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AUSTRALIAN PROGRESS—MELBOURNE.

THE colony of Victoria, which was politically separated from New South Wales in July, 1851, is situated at the southeast of the continent of Australia, and lies between the parallels of 34 deg. and 39 deg. south latitude and the meridians of 141 deg. and 150 deg. east longitude. Its boundaries are—on the north and northeast, the colony of New South Wales, from which it is separated by the River Murray and an imaginary line running in a southeasterly direction from the Springs on Forest Hill to Cape Howe; on the west by South Australia—the 141st meridian of east longitude dividing the two colonies; south and southeast, the Southern Ocean, Bass's Strait, and the Pacific Ocean. Its extreme length from east to west is 480 miles, its breadth 240 miles, and its area 87,884 square miles, or 56,245,760 acres.

The coast line, broken by several bays and capes, is about 600 geographical miles. It is estimated to be about one thirty-fourth part of the entire continent, and, comparing it with Great Britain (excluding the islands in the British seas), it is about 1,800 square miles less in area.

A range of mountains traverses the entire length of the colony, dividing it into two unequal parts. This range runs in an eastern and western direction, generally at a distance of sixty or seventy miles from the seacoast. It is part of the Australian Cordillera, and is called the Dividing Range; all the Victorian rivers have their sources in this range or in its spurs, those to the north running toward the Murray and those to the south flowing into the sea. Its eastern part, which divides the Gipps Land district from the Murray, is known as the Australian Alps. The Murray, the Goulburn, the Yarra-Yarra, and one or two of the Gipps Land streams, are navigable rivers; the Murray is a large river, with a course of 1,300 miles, flowing generally westward, 980 miles of its course being along the northern border of Victoria. The principal harbors are in Port Phillip Bay, forty miles long, and about the same width at the widest part, area about 800 square miles, the head waters of which are called Hobson's Bay, and form the port of Melbourne; the southwestern waters of Port Phillip Bay form Corio Bay, on the shores of which Geelong is located; other harbors are Portland Bay, Port Fairy, Western Port, and Port Albert.

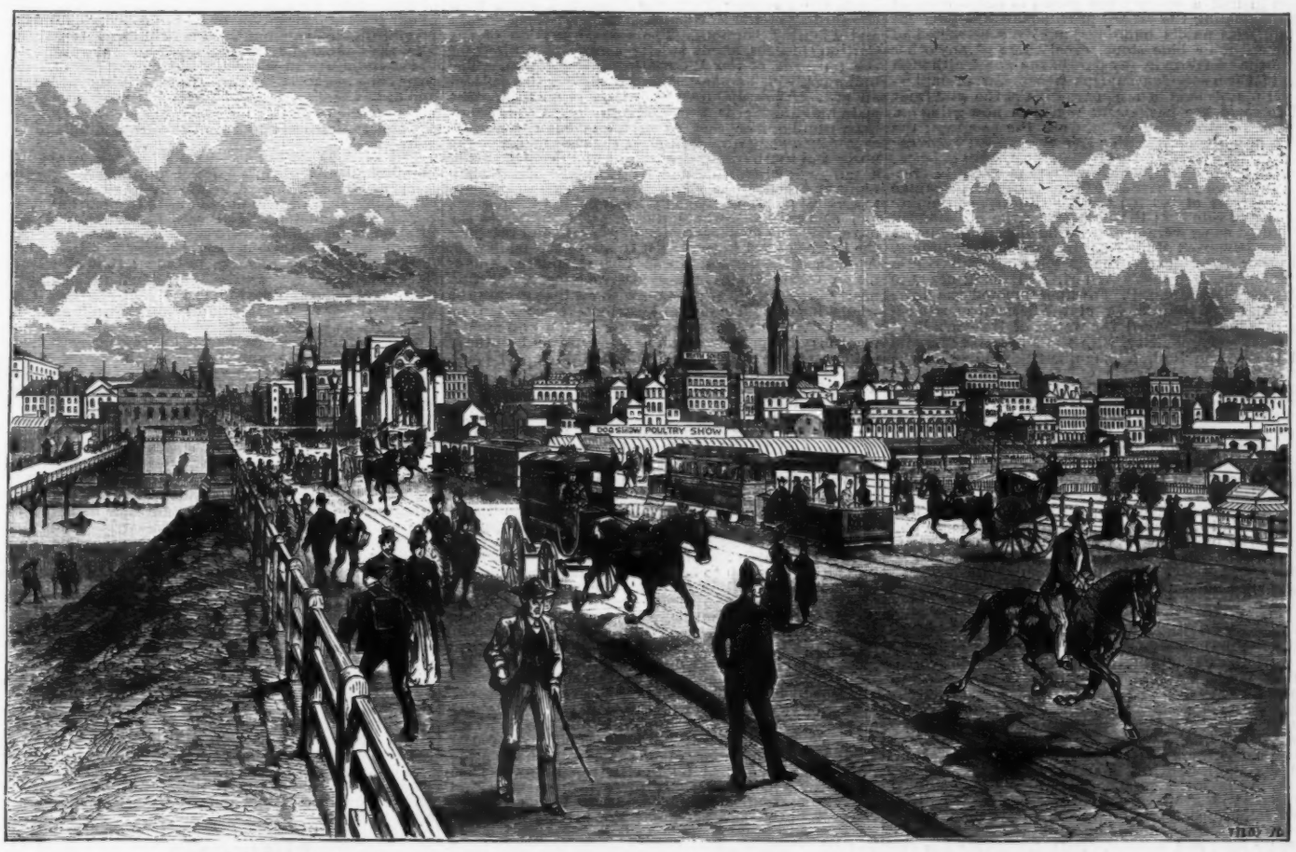
The soil and climate of Victoria are most favorable to agriculture, growing wheat, barley, and oats, potatoes, rye, pease, beans, maize, sorghum, mangold-wurzel and roots, clover, and various fodder grasses. Of tobacco, too, a large breadth has been devoted to cultivation.

Among other things which have been successfully tried are hemp, flax, hops, chicory, beet, canary grass; and, in some localities, olives, oranges, guavas, black mulberries, and other fruits. The cereals do remarkably well. The greatest weight recorded of a bushel of wheat is 69 lb. 4 oz., the average is about 61 lb.; the average weight of oats is 40 lb., of barley 51 lb., and of maize 55 lb. As many as fifty and sixty bushels of wheat, sixty bushels of oats, and forty-two bushels of barley per acre have been obtained; but these returns are unusual. The wines made in the colony have taken a high place in the estimation of European connoisseurs. The apple, pear, peach, and nectarine, apricot, almond, gooseberry, currant, and fig, and the cabbage, cauliflower, turnip, carrot, parsnip, asparagus, pea, bean, water melon, rock melon, and tomato may be seen all growing together luxuriantly in the same plot of ground, while the borders blossom with the fuchsia, geranium, violet, daisy, and other common flowers of the English garden.

The mineral wealth of Victoria is great and diversified, but the wonderfully rapid progress of this colony is mainly due to its gold. One-third of the entire area of the country is believed to be occupied by gold-bearing rocks. The gold occurs in quartz and alluvium; the latter was, of course, the first worked, surface mining being comparatively easy. This was, however, quickly exhausted, and some of the sinkings are now carried on at considerable depths. Quartz reefing is now extensively followed, employing much machinery and a large amount of capital; and owing to the improvements in obtaining gold from the quartz, a yield of a few dwts. to the ton is found remunerative. The seven mining districts into which the colony is divided are Ballarat, Beechworth, Sandhurst, Maryborough, Castlemaine, Ararat, and Gipps Land. In the districts of Ballarat, Castlemaine, Maryborough, and Sandhurst there was an increase in the average yield per ton as compared with the previous year. Some of the quartz mines are now worked to a depth exceeding 2,409 ft., and, so far as can be observed, there is little diminution in the yield of gold. For the past, to the end of 1886, the quantities and values of the principal metals and minerals raised since the discovery of the gold fields were—gold 54,424,399 oz., value £217,697,596; silver raised and exported, 255,578 oz., valued at £55,865; tin ore raised, smelted, and exported, in all, £342,459; copper ore, copper, and regulus exported, value £119,530; antimony ore raised and exported, value £202,768; lead, 660 tons of ore raised, producing metal of the value of £5,326; iron, 5,429 tons, value £12,535; coal, 13,153 tons, valued at £17,506; lignite, 8,619 tons; kaolin, slates, flagging, magnesite, gypsum, mineral earths and clays.

Although Victoria has not such extensive natural pastures as New South Wales and Queensland, stock raising, the breeding of sheep, and the production of fine wool are carried on, by different methods, with superior skill and care. The stock returns to March 1, 1887, were: 308,553 horses; 1,303,265 cattle, of which number 335,727 were milch cows; 10,700,403 sheep; 240,957 pigs.

All the railways in the colony are the property of the state. In the year ending June 30, 1887, there were 1,880 miles of line open, and 521¾ miles in course of construction. The total cost of the lines was £26,171,609, being an average of £13,921 per mile for the 1,880 miles open. The net revenue paid on the capital cost was 3·92 per cent. Melbourne has railway communication with all the up-country towns, and with Adelaide and Sydney.



PRINCE'S BRIDGE, MELBOURNE, THE CAPITAL OF VICTORIA, AUSTRALIA.

Very many things are now manufactured in the colony, aided by the heavy protective tariff. The number of manufactories, large and small, of all kinds, is 5,783, employing 16,663 horse power and 51,469 hands, the value of premises and plant being £8,939,641. Among the exports during 1886 were: gold, inclusive of specie, £1,947,703; leather, £269,399; tallow, £121,900; wool, 107,984,839 lb., valued at £4,999,662; grain, £180,547; apparel and slops, £218,012; live stock, £394,475. The total value of the products of the colony, comprising gold, wool, tallow, hides, breadstuffs, minerals, bark and timber, manufactures, etc., exported in 1886, was £11,795,321. The value per head of the population was £11 19s. The total of yearly exports varies between twelve and sixteen millions sterling.

The government revenue is about six millions and a half, the public debt of the colony is about thirty millions, of which above twenty-five millions are represented by the railways. Victoria is under the control of a governor appointed by the British government, whose term of office is seven years, and of an executive council and two houses of legislature. The executive consists of the governor of the colony and the ministry for the time being. The legislative council is elected on a property franchise. The legislative assembly consists of eighty-six members, representing fifty-five

electoral districts, containing, according to the latest return, 224,378 electors. It is triennial in its duration. Members are paid £300 per annum for their expenses. The qualifications of a voter are so easy that the system may be considered one of universal suffrage.

Victoria is divided into thirty-seven counties, and there are for the purposes of local self-government fifty-nine cities, towns, or boroughs, and 125 shires with municipal bodies. In 1886 the value of the ratable property in the cities, towns, and boroughs was £53,905,592; annual value, £4,824,911; revenue, £615,612. In the shires the value of ratable property was £71,973,156; annual value, £4,706,224; revenue, £615,123. From 1875 to 1885 upward of 3½ millions sterling had been paid out of the state funds to the various local bodies. The estimated population of Melbourne and suburbs at the latest date was 395,000, inclusive of South Melbourne City, 37,000; Prahran City, 32,606; Richmond City, 31,286; Fitzroy City, 30,295; and Collingwood City, 28,800. The populations of the four principal extra-metropolitan towns in 1886 were as follows: Ballarat, 41,110; Sandhurst, 36,570; Geelong, 20,890; and Castlemaine, 9,400. The estimated population of the colony on June 30, 1887, was 1,019,106—viz., 540,954 males and 478,152 females. The number of the aboriginal race does not exceed eight hundred.

MELBOURNE.

The city of Melbourne—the greatest city outside the United Kingdom within the British empire, having a population of nearly 400,000, urban and suburban, within a ten-mile radius—is the metropolis of Victoria. Its central site, on the north bank of the Yarra-Yarra, two or three miles from the sea or Hobson's Bay, was in 1836 known as "Beargrass;" and a few turf or plank huts were then standing, while native "black-fellows," sheltering themselves at night with a screen made of bark, hung around the humble European settlement, which in half a century has grown to stateliness and wealth equaling the largest provincial towns in Great Britain. Its public buildings, mostly constructed of an imperishable blue stone, excel those of any other city of the same size in any part of the world, although some of them—the parliament houses for example—are yet unfinished. The construction of the west front and dome of the parliament houses is now going on. The most noteworthy edifices are the treasury; the houses of parliament (with a library of 35,000 volumes); the new law courts, in the Italian style, built of brick, faced with sandstone, which were nine years in erection, and have cost over £250,000, occupying a frontage to four streets of 300 ft.; the free library, containing over 110,000 volumes; the post office; the building till lately used as a government printing office; an immense edifice at the back of the treasury for the land, mining, and other departments; the customs house, having a fine frontage to Queen's Wharf, and being near the spot where Mr. John P. Fawkner moored the little craft that was the pioneer of the fleets of merchantmen that have thronged the waters of Hobson's Bay; the mint; the university, with the admirable museum and the Wilson Hall, a magnificent building in the perpendicular Gothic style of architecture, having a length of 140 ft., a breadth of 47 ft., and height of 47 ft. at walls to 84 ft. at the apex of the roof; the new town hall, having a spacious room capable of seating 4,000 persons, with one of the finest organs in the world; the various places of worship; St. Patrick's Cathedral (Roman Catholic), which has for many years been in course of erection; the insurance offices; the exchange—a handsome building at the rear of the old Hall of Commerce, with a fine hall; the theaters and the new Victoria Hall in Bourke street, and many large and handsomely built hotels. Conspicuous from every part of the city is Government House, a palatial building, with a square tower 145 ft. high, from whose summit a magnificent panorama of land and sea is obtainable, and in which the representative of royalty is fittingly lodged. A cathedral for the Church of England, now in course of erection from the designs of Mr. Butterfield, is at the corner of Swanston and Flinders streets. Its extreme external length will be 273 ft., width 126 ft., central tower 156 ft. high, with lofty spire; it will afford accommodation for 1,700 persons. Among the banking premises are the Bank of Australasia, a massive building of the Doric order; the London Chartered Bank, in the Græco-Italian style; the Bank of Victoria, the Bank of New Zealand, the Colonial Bank, and the English, Scottish, and Australian Chartered Bank, in the Gothic style.

The port of Melbourne is at Sandridge (now called Port Melbourne), a township 2½ miles distant, situated on Hobson's Bay, and connected with the metropolis by road and railway. Port Melbourne has two large and commodious piers, jutting out a long way into the bay, affording accommodation for a large fleet, and allowing vessels of almost any tonnage to berth alongside. Hobson's Bay has accommodation for 800 vessels; it varies in depth from three to five fathoms, and has good anchorage, the bottom of stiff clay and mud. There is access for steamers and vessels of considerable size to the very heart of the city by means of the river Yarra-Yarra, which is navigable to Melbourne. A dike of basaltic rock, known as the falls, has been blasted away, and the river is now uninterrupted and is tidal to Richmond. Immediately below the falls are the Queen's, Cole's, and Australian wharves, extending for about a mile along the north bank of the river, and used almost solely by intercolonial trading vessels and steamers, and, the Australian wharf especially, by colliers. A dry dock is here, which will admit of ships of 1,100 tons being taken in, and a wet dock of large area is proposed, to which the railway from Spencer street would be connected. On the opposite bank of the river are ship repairing yards, foundries, and many other manufactories, also a stone wharf, built at great cost, alongside which large vessels can be accommodated, and having a very large steam crane, capable of lifting up to fifty tons from the ships that berth there. Between this and the Queen's wharf opposite is the pool, an expansion of the river, where the largest vessels using this navigation can turn with ease. At present vessels drawing 16 ft. can get to the Melbourne wharves at ordinary tides, and 18 ft. at high tides, and this depth will be increased. Since 1877 the water has been deepened 3 ft., and the minimum depth at low water is now 14 ft. 6 in. at spring tides. A canal to Sandridge has been under consideration, but Sir John Coode has submitted plans for the improvement of the Yarra, which have partially been acted upon—a great advantage to all vessels coming up to Melbourne.

The city is plentifully supplied with omnibuses similar to those in use in New York, cars, cabs, wagonettes, and other facilities for suburban and street conveyance, which run at cheap fares. Cable tramways now traverse several of the leading streets, and others are in course of construction. There are three railway stations—one in Spencer street, being the terminus of the up-country lines; the second in Flinders street, from which the suburban trains to Port Melbourne, South Melbourne, St. Kilda, Brighton, and other places run; and the third at Prince's Bridge, the starting point of the trains to Hawthorn, Camberwell, and Gipps Land. The principal streets in Melbourne proper are one mile in length, 99 ft. in width, and run at right angles to each other; they are intersected by smaller streets which bear the name of the larger streets with the prefix of "Little." These leading thoroughfares are named, respectively, after Australian notabilities—Flinders, Collins, Bourke, Lonsdale, and Latrobe, running nearly east and west; and cross streets called Spencer, King, William, Queen, Elizabeth, Swanston, Russell, Exhibition, and Spring streets. Elizabeth street, in the valley of the two principal hills on which the city is situated, divides East Melbourne from West Melbourne. The adjacent suburbs, North Melbourne, Collingwood, Fitzroy, Carlton, Brunswick, South Melbourne, Prahran, and Richmond, present fine streets and roads, good private houses and shops. Prince's Bridge, lately reconstructed of iron, from the designs of Messrs. Jenkins & Granger, crosses the river by three spans of 100 ft., and there are many other bridges. Melbourne has its public parks and gardens. The Royal Park, with a good zoological collection; the Botanical Gardens, on the south side of the Yarra; the beautiful Fitzroy Gardens, laid out with great taste and skill, containing a pleasing variety of trees and flowers; the Studley Park, the Fawkner Park, the Richmond Park, with the gardens of the Horticultural Society; the Treasury and Flagstaff Gardens. The central portion of the Carlton Gardens, about twenty acres, was utilized for the purposes of the International Exhibition. The buildings, which cost altogether some £250,000, covered an area of five and one-half acres of ground. The main building is cruciform, and consists of a nave 500 ft. long, running from east to west, and cut through its center by a transept 270 ft. deep, the ends of which are north and south; at the south end is the chief portal, a tall arch 40 ft. wide and 60 ft. high, reached by a flight of broad stone steps. On each side are square towers 105 ft. high. Some fifty feet behind the portico, and at the point where the transept intersects the nave, rises the dome, octagonal in form, and reaching the height of 223 ft., some 130 ft. above the main roof. At its base the central tower is 100 ft. square. In addition to the main building were annexes covering nearly fifteen acres of ground, with center avenues the whole length. These annexes have since been removed. Among the places of recreation and amusement may be mentioned the new picture and statuary gallery, at the rear of the public library. The Melbourne Observatory, on the south side of the river Yarra, is provided with appliances of the first order, and the telescope ranks among the largest now in use. The Melbourne race course, with a handsome grand stand, situated at Flemington, and the Melbourne cricket ground, in the Richmond Reserve, also possessing an elegant and roomy stand and a fine brick pavilion with flat roof, are nowhere surpassed. The race course on cup and other principal race days is thronged by a concourse of people rivaling that on the Epsom Downs; and the Melbourne cricket ground during Intercolonial and All-England matches presents a sight hardly to be seen elsewhere, upward of 12,000 persons having been known to be present. The inhabitants of Melbourne are well provided with means of entertainment. There are five theaters, and the Victoria Hall for concerts of good music, while for social intercourse there are the Melbourne Club and the Athenæum Club; and the Mechanics' Institute, now called the Athenæum, has a good library and lecture hall. The Eastern Market, rebuilt at a cost of £77,000, is lighted at night by electricity. There are several other markets. The city is everywhere well paved and lighted, and is supplied with good water from the Yan-Yean reservoir, but the supply will be increased by 25,000,000 gallons on the completion of the Watts River Aqueduct. Gas is supplied by the Metropolitan Gas Company, an amalgamation of three former companies. The city and suburban police stations, the government offices, and the offices of numerous private firms have communication by telephone. The shops, warehouses, and other commercial establishments, by their handsome exteriors, bear witness to the activity of profitable trade. No deficiency or inferiority will be observed by the newly-arrived immigrant who has been accustomed to Liverpool or Glasgow, except in three particulars: the cabs are bad; the carriage roadway, off the principal thoroughfares, is often badly out of repair; and many of the roads are rendered disagreeable by open sewers. These faults ought soon to be amended.

Town building land in Melbourne often realizes enormous prices; in one case £5 a square foot was paid for a street frontage, and the purchaser resold it for £9 15s. a foot. These sales cause wild excitement among the speculators at Melbourne.—*Illustrated London News.*

AN AID TO COMMUNITY LIFE.

IN modern times family life has made unquestioned advances. There is a great deal said about the deterioration of the home, the decay of parental authority, the loss of that old-time discipline which was the secret of strong character. But, on the whole, facts do not justify these inferences. The home was never more potential in this country than to-day; never was more thought put into it, more intelligence devoted to its concerns, more time and money invested in its building up. Our communities are strongly developed on the side of home life; but they are largely undeveloped on the side of community life. Community life, which is a very different thing from purely social life, is still in a rudimentary state among us. We hardly know what the words mean, we have done so little to illustrate and interpret them.

A community acts together on the questions that concern its pocket; it divides on everything else. It is educated in separate schools, worships in separate churches, is buried generally in separate cemeteries. It votes together, but in all the other great concerns of life it has no organic union. No one who has given the matter any study can doubt that just here our American civilization at least misses a great deal that would enrich and beautify it, and our separate communities lose something that would give them not only a new consciousness of human fellowship, but an added resource in their daily lives. Each community ought to have an organic life of its own, in which every member may play its own part, and every individual feel its duty and its inspiration. How few communities have anything approaching this sense of community life; how rarely one finds even a hint of it in any large enterprise! There are a great many public libraries which are doing an admirable work, but even these are often so housed and conducted as to make a large section of the community feel ill at ease within their walls. And yet every such library contains the germ of an institution in which the organic life of the community might realize itself.

A teacher in a New England town, who has the happy faculty not only of inducing the young idea to show itself, but of giving the mature idea a more generous impulse, not long ago sketched privately his plan for working out the community idea. The heart of such an enterprise is that it should collect under one roof all the interests of the place; that under this roof it should abolish social distinctions and religious differences, and emphasize solely and continually the fact that men have certain common interests and a definite common life from the mere fact that they are parts of a community. This teacher proposes what he calls "a People's University," and although at first sight the plan may seem a little chimerical, it will prove upon further examination to be essentially a simple and thoroughly practical scheme.

It is true the plan is a little in advance of the thought of most people about these things, decidedly in advance of our present conception, or lack of conception, of the possibilities of community life. It may serve, therefore, the double purpose of giving practical suggestion to those who are already looking for some way of using their culture and their money to the best advantage and of awakening those who have not yet become conscious of the needs of the social order of to-day and of the almost limitless opportunities of extending and developing it.

The plan suggested may be put in a few words. It involves the erection of a suitable building in a proper location; the building to be worthy in all respects of the community, and yet not so fine as to make any member of the community ill at ease under its roof; the location to be central, convenient, and commanding. In this building there should be, free to all, a public library and reading room, so managed that it should have constantly in mind the intellectual needs of the place, and so hospitable in its spirit and direction that every member of the community should feel at home in it. Under the roof of this building, and with the library as a nucleus, various combinations may be made suitable to the needs and special opportunities of the place.

A physical and chemical laboratory may be added, with their necessary appliances and instruments. A manual training school thoroughly equipped in educational appliances will meet another need, perhaps the most pressing of all. There may be under the same roof a historical museum, in which shall be collected all the memorials of the past life of the town, illustrative, so far as possible, of its continued existence as a community. There, for instance, ought to be gathered all the works of the prehistoric days—arrow heads and memorials of the times of Indian domination; there should be the spinning wheel and other household implements illustrative of colonial habits and ways; there should be seen relics of the revolutionary struggle and of the war of the rebellion. Every community of any date contains most interesting and valuable material of this sort, and if it were gathered in one place it would furnish a visible history of the life of the community.

Under the same roof there should be a room for a sewing school, pleasantly and cheerfully furnished in such a way as to teach the eye of the young girl who comes there the elements of the cheer, the cleanliness, and the beauty which ought to go into the making of every home. Under the same roof should be provided two or three rooms for miscellaneous work, rooms in which classes can be taught on winter nights, with one larger room for lectures, and with an audience room for large public gatherings.

This is but the bare suggestion of a scheme which may be elaborated in many ways and adapted to the special needs of any community. In a manufacturing town large importance ought to be attached to the manual training school, where the use of tools shall be taught and the eye and hand educated to a just sense of proportion and to accuracy and thoroughness; in such a community the sewing school would also be of great service. In a country community, where agricultural interests are large and important, the physical and chemical laboratory might be the center of an important activity.

In every community the library ought to be the focus of thorough work. But the question is immediately asked, After this building is provided and these tools are furnished, who is to do the work? It is just here that the most important influence of such an institution is to be sought. For while such a building, properly managed, would furnish to the less favored members of the community large opportunities for growth, it would also furnish to the same favored members a training school for the working out of those ideas of sacrifice and service which are fundamental in the Christian conception of living. Every community of any size contains cultivated men and women who are qualified to teach their fellows, and who owe their fellows a service which in most cases is never rendered. It would be a very easy matter, in such a building as has been outlined, to bring together the moral and intellectual need and the moral and intellectual supply in every community. There those who need the opening of the eye and the mind could come, and there also those who are fitted to carry on this work of enlightenment would find their proper opportunity.

There the minister or the student of literature could suggest lists of books and courses of reading adapted to individual needs, and could organize and conduct classes

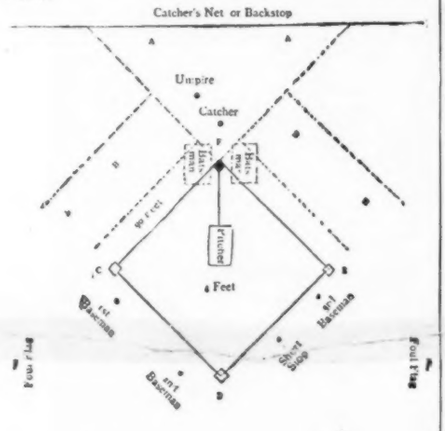
for the study of literature; there the professional teacher who could give two hours a week of his time, or the amateur chemist who relieves the pressure of his daily business by experimentation and study in his laboratory, could teach chemistry. The study of history might be organized by half a dozen people interested in different epochs and countries, the historical museum serving as a starting point and center. Every community counts some good historical students among its citizens. The botanist of the town might have room and time to collect about him those who are interested in the study of the flora of the locality; the mineralogist would have the opportunity of gathering together a class in his favorite science. Music, phonography, bookkeeping, art, may each find convenient and hospitable lodgment under the community roof. The lawyers may give talks on the elementary principles of civil government, on town organization, and the duties of citizenship. The business men may discuss the tariff, commerce, coinage, a hundred other matters that the most ignorant man is interested in if he can only find some one to talk to him about them in a way he can understand.

The applications of such a scheme are many; its adaptability is one of the features which will commend it to those of practical mind. In certain details and for the purpose of reaching the poor this plan has already been worked in some localities. But it has not been worked, as a whole, upon the community idea. It is not as an alleviation of poverty, as a concession to a class, that it ought to be conceived; but as an expression of community feeling, as a medium of community life. The rich and well-to-do would receive as much from it as the poor—perhaps more. It would serve the highest possible educational purpose, because it would illustrate and enforce certain fundamental ideas which are now largely lost sight of.—*Christian Union.*

[FROM THE LONDON GRAPHIC.]

BASE BALL.

THE arrival in this country of a specially selected team of players will no doubt stimulate the interest in this, the great national pastime of the United States, and some account of it may, therefore, be found interesting.



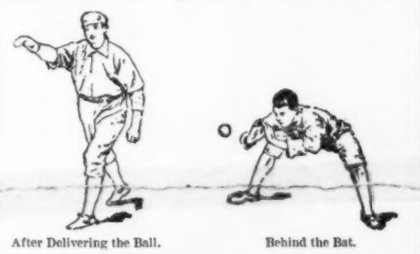
A A A. Ground reserved for catcher and umpire. B B B. Coaching ground for captain and assistant. C. 1st base. D. 2d base. E. 3d base. F. Home plate or base.

The game is an outgrowth of "rounders," which might naturally be thought to be too elementary a sport to be susceptible of much scientific development. As a matter of fact, however, base ball is an exceedingly scientific game, and requires so high a degree of expertness in those who are proficient in it as to exclude all but professionals. The "properties" of the game are a bat and a ball and three square bags for bases. The bat is essentially different from the cricket bat, as it is round and much longer. It tapers from the end, where it may not be more than two and a half inches in diameter, to the handle, and it is not more than forty-two inches in length. The ball must weigh not less than five nor more than five and a quarter ounces, and be not less than nine nor more than nine and a quarter inches in circumference. It is made of woolen yarn wrapped tightly around an ounce of vulcanized rubber, and is covered with leather—horse hide being commonly used. It will thus be seen that it is lighter and more elastic than the cricket ball, and, therefore, more difficult to field.

There are nine players on a side, and nine innings, in each of which three players only on each side go to the bat, constituting a game. The fielders are catcher, pitcher, first baseman, second baseman, third baseman, short stop, left, center, and right fielders. Play having been called, the first man in the batting order of the side having first innings takes his place in one of the parallelograms marked batsman, the one on the left of the catcher if he is right-handed, and the one on the right if he is left-handed. The pitcher then pitches the ball from the box marked pitcher, and, without raising his hand above his shoulder, may deliver the ball in any style he pleases. He must, however, send it over the home plate, by the side of which the batsman stands, and not higher than the shoulder or lower than the knees of the latter. As the home plate is only twelve inches square, and is fifty feet distant, it will be seen that great accuracy is required. The pitcher's object, of course, is to deceive the batsman in every possible way, and thus prevent him from hitting the ball. The best pitchers have become most expert, and are able to send the ball at terrific pace and with great accuracy in curves of all kinds—out-curves, in-curves, down-shoots, and risers—so that only the keenest-eyed and coolest-witted batsmen are able to hit it. A number of games have been played in which not a single bit has been made. This means that nine men have each tried three different times to hit the ball, and failed to do so. When it is remembered that these feats of pitching have been accomplished against professional players selected for their expertness with the bat, the performance seems almost incredible. In order to restrict the power of the pitcher, the rules require that if he fails six times to deliver the ball squarely over the home plate, the batsman may go to the first base, as if he had made a hit. At the same time, the striker is not privileged to be captious about the kind of ball he is to strike at, but if he fails to strike at

The Batsman's Position. First Position of Pitcher. Pitching the Ball.

three "good" balls—that is, balls that pass over the plate at the right height—he is "out," as if he had struck at the balls and failed to hit them. The batsman, if he be lucky or skillful enough to make a hit, drops his bat and attempts to make the round of the bases. If he succeeds, he scores a run for his side, and herein the game of base ball resembles its prototype "rounders." But it is no easy matter to score. In the first place, the striker must drive the ball within the lines running from the home plate to first base, and from the home plate to third base, and imaginarily extended to the "foul" flags. If it falls outside these lines it is a "foul" ball, and no point can be made on it, although, if caught, the player may be put out. If he succeeds in sending the ball within the lines, and it is not caught, it may yet be fielded to the first baseman; and if the latter, standing with one foot on the bag, catches the ball thus thrown to him before the striker reaches the base, the striker is out. If, however, he reaches the base before the ball gets there, he is safe. The next batsman then takes his place at the home plate. His object is not only to make a hit, but to drive the ball in such a direction as to assist his predecessor around the bases.



After Delivering the Ball. Behind the Bat.

The latter will not, if he sees an opportunity, wait for the aid of his colleague at the bat, but will "steal second base," that is, make a dash for it when the pitcher is in the act of delivering the ball. This is hazardous, as the catcher at this stage of the game plays well up behind the bat, and, receiving the ball, throws it rapidly to the second baseman, who, if he is able to touch the runner with it, puts him out. The runner, to escape being touched, generally dives and slides for ten or fifteen feet to the base. The batsmen strike in turn until three are out, when the side is out, and the nine who have been in the field come in for their innings.

The game has gained a remarkable hold upon the American people. It has, in their opinion, many advantages over cricket. It is quicker and livelier, and has more diversity. A full game is usually played in two hours, or less. This enables a business man to leave his counting house at three o'clock and witness the game from its opening to its exciting finish. The scoring does not depend solely on the batting, but on base running, in which fleetness of foot, pluck and daring, and indifference to injury are required. Base

Sliding for a Base. $10,000 Kelly.

running is also the low comedy of the performance, and the antics of a well-known base runner in his efforts to elude the vigilance of the pitcher and catcher and "steal" a base keeps the audience constantly amused. This feature of the sport necessitates frequent throwing to the bases, and often occasions brilliant displays of fielding.

The excitement of the game arises in large part from local rivalry between the cities composing the playing circuits. Each of the large cities has its club, which is often an object of pride and enthusiasm. Its games at home are witnessed by thousands of spectators, who pay, for entrance to the grounds, two shillings, and from two to four shillings additional for reserved seats. When the club is playing away from home, the streets are thronged with crowds eager to see the results of the innings as bulletined from the newspaper offices. Some idea of the attractiveness of the sport may be gathered from the fact that, last summer, 205,000 people saw the sixty-seven games played at home by the Boston club. The clubs in the leading cities have extensive grounds, with improvements of a permanent character, including seats arranged in the form of an amphitheater for spectators, and reading rooms and gymnasiums for the players. The latter receive salaries ranging from eighteen hundred to five thousand dollars for the season. A crack pitcher can command from six hundred to a thousand pounds for six months' work, and as he has always one or more alternates, he really works not more than two hours a day for three days each week for this enormous sum. During the time his club is away from home he travels luxuriously in first class saloon carriages and is lodged at the best hotels. Although a professional, the paid ball player is not unfrequently a man of superior walk in life, the high compensation attracting students from the colleges and universities into the ranks of the players. Capt. Ward, in charge of the All America Nine, is a member of the New York bar. Scores of self-respecting young men have, like him, become professionals while completing their studies for law, medicine, dentistry, and even divinity.

The several clubs are confederated into organizations for mutual protection and the elevation and improvement of the game. In order to prevent the players from deserting their clubs, each club has the right at the close of the season to reserve eleven of its players, and the men so reserved must either sign contracts to play during the ensuing season with the clubs reserving them or abandon playing altogether. It often happens that a club greatly desiring the services of a player under contract or reservation with another club purchases his release; and at a price which seems incredible. In 1886 the Boston club paid two thousand pounds for the release of Kelly from the Chicago club. He has since been known as "Ten Thousand Dollar Kelly." The Boston club, owing to the great popularity of the player and the increased interest he gave to their games, found the transaction a profitable one financially.

NEWTON CRANE.

STEAM JET PHENOMENA.

HERR R. VON HELMHOLTZ has sent to *Wiedemann's Annalen* some observations made by himself upon a jet of steam. He remarks that a jet of steam escaping from a hole of one or two millimeters diameter, lighted obliquely and observed upon a black background, is invisible at the lower extremity, and presents toward the top the well-known whitish appearance. This aspect may be modified in many ways. If an electrified point is brought near the steam, the jet immediately becomes azure blue, or, according to the power of the electrical machine, purple, red, yellow, green, etc. These tints are intimately connected with the dimensions of the liquid drops, and hence it follows that the electrical point has the power of provoking condensation of the supersaturated vapor which is found at the lower part of the jet.

The same result is obtained by bringing near to the steam jet a platinum wire made brightly incandescent by an electrical current, or silver, iron, copper, or brass wires simply made red hot in a flame, or even glass heated below the red, or an organic matter, wood, paper, etc., in a state of slow combustion. The products of any flame whatever, with the exception of the flame of pure alcohol, directed upon the jet steam by the aid of a chimney or by simply blowing, produce a very energetic effect. Finally, traces of certain chemical substances introduced into the steam jet cause the same modification. Among these are hydrochloric and nitric acid, but concentrated sulphuric acid especially shows the phenomenon. It is known that solid dust particles provoke the condensation of supersaturated vapors, but their presence cannot be invoked here to explain the preceding facts.

The author is of opinion that they may be attributed to a molecular concussion, the effect of which may be compared to that of mechanical concussion upon superheated or supersaturated liquids. A flame, for example, is the scene of closely approximated and extremely varied movements, and the chemical atoms which are incessantly passing in it from one combination to another are found in every kind of unstable condition. These movements and changeful states of equilibrium leave their traces in the products of combustion at a certain distance from the flame properly so called, and determine the observed phenomena. The luminous effect produced as the extremity of an electrified point and the presence of ozone in its vicinity show that this point is the cause of concussions comparable to those provoked by active combustion, and the analogy between the two phenomena is found again in the fact that they both furnish means for making electricity pass through gas. As to solid incandescent bodies, they can act either through the emission of solid particles from their surfaces or by the chemical concussions which they communicate to the surrounding gases.

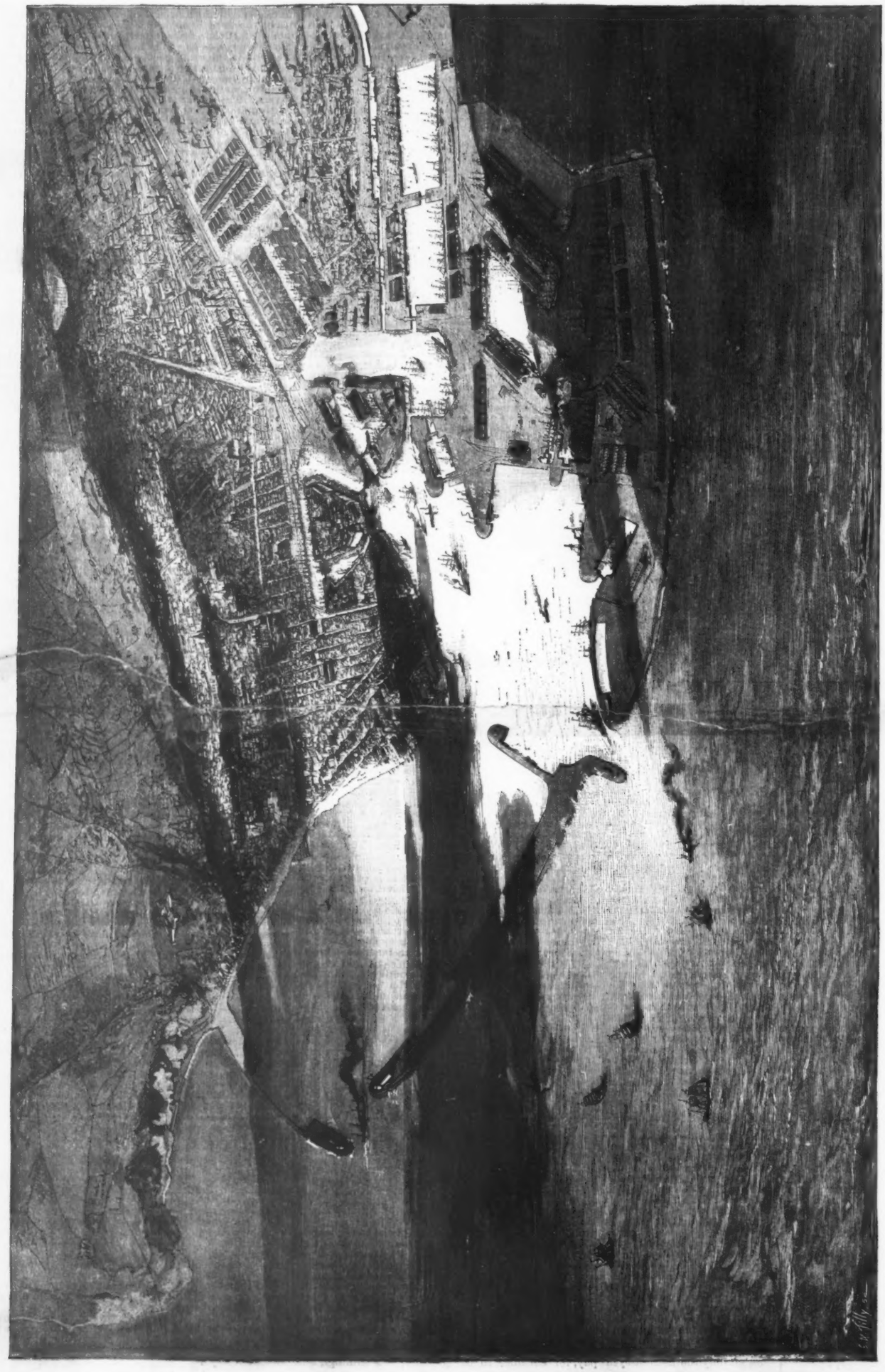
CLINICAL STUDY OF BACTERIA.

By A. CLIFFORD MERCER, M.D., F.R.M.S.

THE working distance of homogeneous immersion objectives of short focus and great numerical aperture is little. In the clinical study of bacteria, sputa and other more or less fluid material are generally prepared on the under surface of cover glasses, commonly, when not measured and assorted, so thick as to make examination with the above most suitable objectives impossible.

To avoid this difficulty I dry and stain the material on the slide, drop homogeneous immersion fluid upon the preparation and lower the objective into the drop. Homogeneous fluid replaces both the balsam and the cover glass with optical propriety.

A twenty-fifth, which has been nearly useless over ordinary cover glass preparations, is now used with gratifying freedom in manipulation over uncovered, but homogeneously immersed, slide preparations.—*The Microscope.*



THE ENLARGEMENT OF THE PORT OF HAVRE.

IMPROVEMENT OF THE PORT OF HAVRE.

RIGHT in the midst of the most active political work, the Chamber has just decided a question of political interest which has now for a long time engrossed the attention of those who have at heart the commercial future of our country, and that is the question of the improvement of the port of Havre.

Mr. Deluns Montaud, who, since he has been in power, has shown himself to be a true man of business, and who has set his heart upon giving this question the solution that it admits of, recalled in the discussion that arose upon the urgency of it that the necessity of developing the port of Havre and giving it a new deep water entrance has been recognized since 1875. In 1879, a commission composed of hydrographers, mariners, and engineers agreed as to such necessity. In 1884, the government indorsed a project known in the parliamentary annals as the Bellot project, but which came to nothing. Finally, in 1885, a commission was again appointed, and drew up a new project, which the Chamber has just voted, and which now only awaits the approval of the Senate. But, since the epoch at which the question was proposed for the first time, events have demonstrated the necessity of arriving at a prompt solution. In fact, it is well known that the port of Havre is the terminus of the line of vessels that put us in communication with America. Now, in every commercial sea service the dimensions of the packets designed for the carriage of passengers and freight tend to increase; and did our companies not maintain a competition by means of as comfortable and swift packets as possible, we should be doomed to a certain forfeiture of it. We too, then, have our monster ships, but these have only three or four times their length for maneuvering in the outer port, and in the very basin especially appropriated to them they have just enough space to swing, that is to say, turn about *in situ*.

It became so much the more urgent to remedy this state of affairs, in that other nations by which we are outdone have already improved their ports in view of the transformation introduced into the construction of swift ships of large tonnage. It is evident that we could not remain in the rear, and it was absolutely necessary that, in the shortest time possible, our great Channel port should be put in a state to cope with the unrestrained competition directed against it. Our economic interest and our moral influence go hand in hand.

It is, therefore, to be hoped that the vote of the Senate, conformable with that of the Chamber, which has decided to pass to the discussion of the articles, will definitely sanction the project now under consideration. As shown in our engraving, this project proposes the construction, outside of the basins, of a vast outer port, having a total area of about 2,750,000 square feet, with two entrances, one of them 490 feet in width, directed toward the southwest and situated upon the present passage, and the other, 656 feet in width, situated 6,200 feet to the north, and looking toward the west—both of them limited simply by wing walls, after which comes a wide expanse of water surface.

Two deep-water passages, one of them in an east and west direction and the other coming from the southwest, give access from the high sea to this west entrance. By means of a few dredgings in the upper part of the small roadstead, there will be easily obtained a depth such that there will be more than twenty-eight feet of water for about eight hours at spring tide and for nine and three-quarter hours at neap tide. In the accessory passage of the southwest there will be even thirty feet at neap and thirty-five at spring tide.

The new outer port will be divided into two parts 1,545 feet in length, the northerly one of which will form a sort of roadstead, externally protected, of an area of 1,257,800 square feet. The larger portion of this will have to be dredged, and will give an anchorage affording at least twenty-five feet of water at the lowest tide known, so as to form a deep-water basin accessible to every ship, in any weather, and at any hour, so to speak. The second port will constitute the south or internal outer port, having a water area of 806,250 square feet, and communicating, on the one hand, with the outer port through an 800 foot opening, and, on the other, with all the basins.

The present outer port will, therefore, be notably modified. The two jetties that now exist will be done away with, as will be also the floating dock opposite the pilots' bay.

Most of the basins will be preserved, but it will be easy to form others in addition, according to the necessity that may be created by the extension of commercial traffic, for the new works will permit of wresting from the sea vast extents of land at the mouth of the Seine, in the region contiguous to the fortifications of the Eure.

Such, as a whole, is the economy of the project whose execution the port of Havre awaits with justifiable impatience.—*L'Illustration.*

AN EARLY RAILWAY.

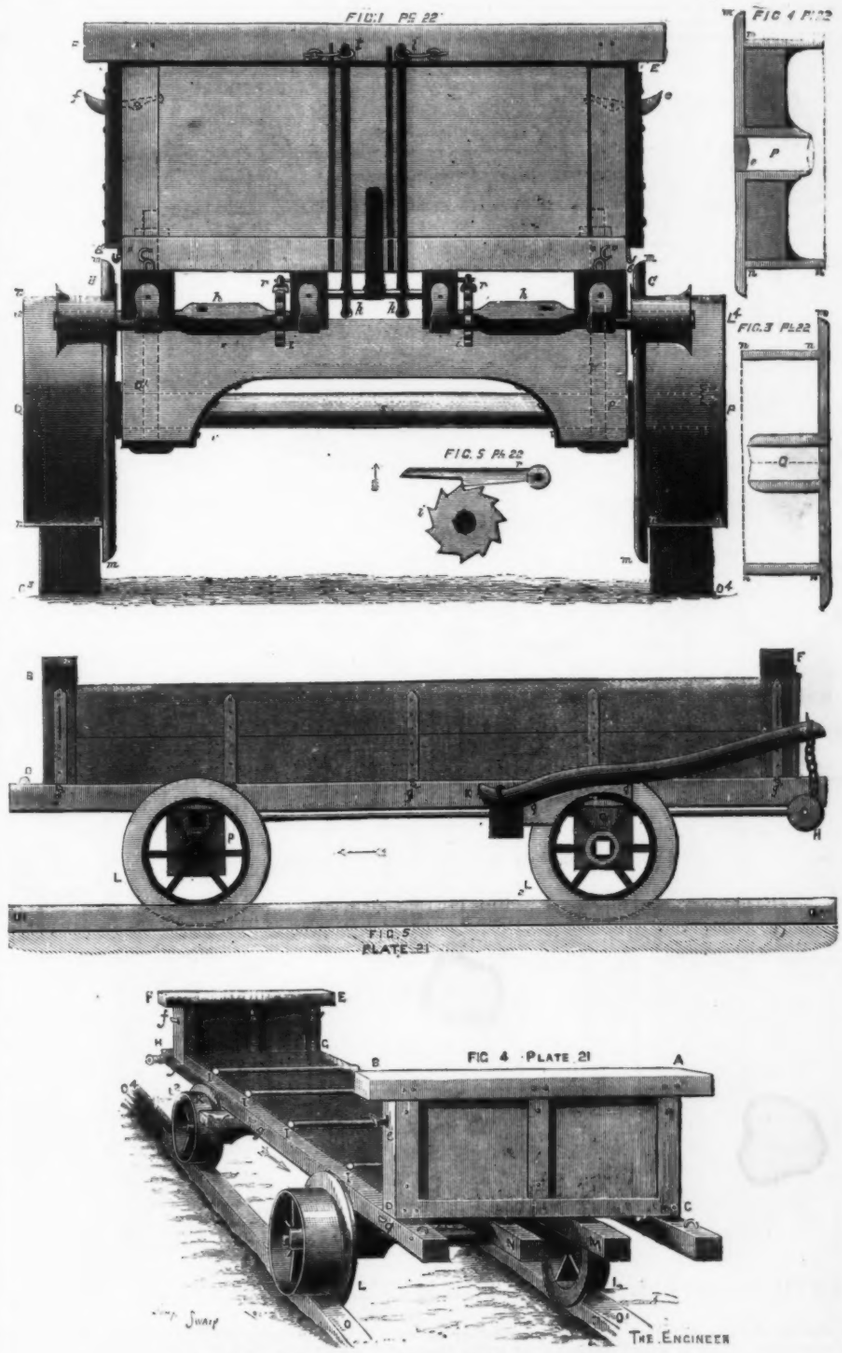
REFERRING to the Box and Corsham quarries in the neighborhood of Bath, which for generations past have yielded large supplies of the celebrated Bath stone, it is not, perhaps, generally known that a very considerable amount of mechanical skill was brought to bear upon the methods of conveying the stone from the quarries early in the last century. We have therefore reproduced from Desaguliers' "Experimental Philosophy" some drawings of the trucks used in that neighborhood at the period just named. The book, which is well known as containing the earliest detailed account of Newcomen's steam engine, was published in 1734, and we find at page 274 of the first volume "a description of the carriages made use of by Ralph Allen, Esq., to carry stone from his quarries situated on the top of a hill to the water side of the river Avon, near the city of Bath." The description is from the pen of Charles de Labelye, the well known architect of Westminster Bridge. Ralph Allen was a very great man in Bath, where he was for many years postmaster. He was the first to propose "cross posts," and he seems to have organized the system on the most complete scale; and as he was also a large contractor for the post office, he accumulated a colossal fortune, out of which he built himself a noble mansion in the neighborhood known as Prior Park. The family survives to the present day, and we believe that it is still represented by a Ralph Allen.

The drawings almost explain themselves, but in the original work they are described with great prolixity through several quarto pages. As the quarries were situated a mile and a half from the river, and about 500 feet above its level, some simple means of transport were necessary, the stone being then sold at a very small price. The system is regarded by Desaguliers as "a great improvement on some carriages and wagon ways made use of at the coal mines near Newcastle." It will be observed that the words *railway* and *truck* are not employed, for, as a matter of fact, they are of very much later origin. The earliest instance of *railway* with which we are acquainted is in one of Smeaton's reports bearing the date of 1775. The side elevation, Fig. 5, is drawn to a scale of one-twentieth the full size, while the end view is on a scale of one-tenth. Perhaps the most striking feature is the wheels—about 20 inch. diameter—which are also shown separately in section in Figs. 3 and 4, Plate 22. It will be seen that the flange is on the inside as now, while on the Newcastle tramways of the time the wheel was without a flange, the rails being L shaped. The wheels ran on the horizontal part, the vertical rib forming a guide to keep the trucks from running off the line. The transfer of the flange from the rails to the wheels was a great improvement, and is usually supposed to belong to the early part of this or the latter end of the previous century. As the trucks had to descend a somewhat steep incline, it was necessary to make some provision for a brake, but here again the word *brake* is not employed.

The wheels are attached to the axles in a rather peculiar manner, the reason for which is not quite apparent. The right hand wheel of the fore axle and the left hand wheel of the hind axle are both fixed, while the corresponding opposite wheels run loose. A different method of braking the wheels of the fore and hind axles is also employed. As regards the hind wheels, the method of applying the brake is shown in Fig. 5, Plate 21, where a "jig pole," with a "compass piece," *g g*, attached, is depressed by a chain, which passes round rollers, H G, Fig. 1, Plate 22. These rollers are caused to revolve by handspikes inserted in the holes, *h h*, and the brakes are kept on by means of the ratchets, *r r*, shown separately in Fig. 5, Plate 22. To release them, the tail of the pawl is raised, when the chain unwinds. It will be seen that each wheel may be braked independently, and the same remark applies to the front pair, though the mechanism is of a different kind, the primitive method of inserting a bar between between the spokes of the wheels being employed. The details are not shown in our engravings, but one of the bars may be seen in end view behind the fore wheel in Fig. 5, Plate 21. These bars are pushed between the wheels by means of the rods, *l k*, *l k*, Fig. 1, Plate 22. In the position shown the bars are clear of the wheels. The whole of this brake mechanism is thus under the control of a man riding at the rear end of the truck.

Each truck is capable of carrying a load of four tons, but the weight when empty is not given. It is, however, stated that one may be easily drawn up the hill when empty by two horses, and that on the level it could be drawn at a good rate even when loaded, there being very little friction, owing to the axles running in brass collars. The cost of each truck amounted to £30.

It will be admitted that a considerable amount of ingenuity is displayed in the mechanical arrangement of this truck, and much greater than is commonly supposed to have existed at the time. It is by far the



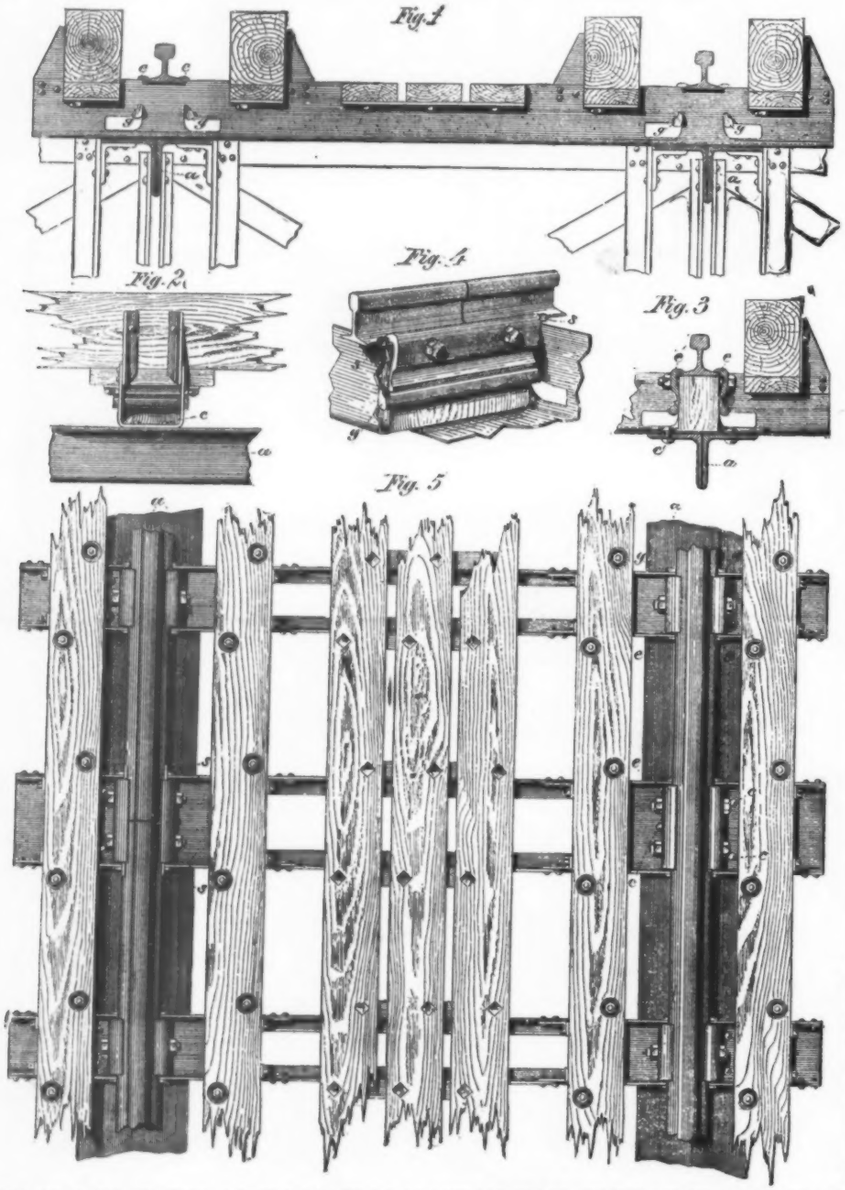
WAGONS ON AN EARLY RAILWAY.

most perfect thing of its kind that we have ever come across, taking into consideration the fact that it was contrived more than a century and a half ago, when "wagon ways" and rolling stock were in a very primitive condition.—*The Engineer.*

STEEL CROSS TIES FOR THE NEW YORK ELEVATED ROADS.

THE growing interest taken in the subject of railway metal cross ties is very manifest by the active and substantial manner in which some of our leading railway managers are giving the subject consideration. Several of our large trunk lines are now experimenting with a view to adopting steel ties in place of wood, believing them to be more advantageous.

In the *Engineering and Mining Journal*, of December 29th last, the evolution of the metal cross tie was illustrated, and this article has attracted much serious attention among railroad men. Preparations are now being made to place a section of "Standard" steel ties



STANDARD STEEL TIES FOR THE MANHATTAN ELEVATED RAILWAY.

on the Manhattan Elevated Railway, preparatory to its adoption. Thus it would appear that while the managers of our surface roads are "giving the matter consideration," Colonel Hain has given it careful study and has already satisfied himself as to the merits and advantages of the steel tie over wood. Evidently Col. Hain knows what he wants, and trusts his own good judgment in deciding what to use rather than wait for some one else to furnish him with experience.

The illustrations herewith represent the form of tie to be used on the elevated road, and show how admirably this tie has been adapted to that structure.

Fig. 1 represents a side elevation of the tie and guard rail braces, showing end views of the rails, guard rails, and central platform, also a fractional view of the upper portion of the structure.

Fig. 2 represents an end view of the tie and guard rail braces, showing portions of the guard rail and upper chord in side elevation.

Fig. 3 illustrates a transverse vertical section through the rail and clips, showing the powerful means employed to hold the rail firm upon the end fiber of the creosoted oak block.

Fig. 4 illustrates the method of making the rail joint, whereby the ends of the rails are held *positively* rigid upon the "joint plate," thus avoiding all possibility of uneven or loose rail joints.

Fig. 5 represents a plan or top view, the details of which are so clear as to need no special description. Every part appears to have received careful study, the result of which is a very perfect structure, showing marked improvement on the present system.

With the elevated road and all bridge structures, the upper chord is the top of the main structure (see *a*, Figs. 1, 2, 3, 5), and upon this chord the wood ties are laid crosswise, and upon the ties the rails and guard rails are laid, crosswise of the ties and longitudinal of the upper chord. The rails are spiked to the ties, and the guard rails are bolted to the ties also; the latter are fastened to the upper chord by what are termed "hook bolts," *i. e.*, the bolt is hooked under the flange of the upper chord and passes up through the tie, and a nut is screwed on the end of the bolt to hold the tie in position. The hook bolt is probably the best device for holding the wood tie that can be devised, yet the ties so held are far from being firm or rigidly connected with the upper chord, simply because the swelling and shrinking of the tie and the strain upon the hook draws the nut and its washer down into the upper surface of the tie and the bolt is quite loose, leaving the tie comparatively free to vibrate.

It is a recognized fact among engineers that rails are quite loose where spike fastenings are employed, the cause of which is generally understood to be the imperfect hold which the spikes have in the wood tie, from the fact that if you do not "drive the spike home," so that its head is seated upon the rail base and the latter upon the tie, the rail is loose from the start, and if you drive the spike with sufficient force to draw the rail down to a proper seat, the fiber of the wood is generally destroyed and the rail will soon become very loose.

Moreover, the present rails, ties, and guard rails are a dead weight, which the structure must carry in addition to the train load, without rendering any assistance to the structure whatever, acting, on the contrary, as intermediate vibrating parts, which pound the upper chords, making great noise and doing injury to the main structure.

These injurious features have been overcome by the adoption of the "Standard" steel ties, which are riveted to the upper chord (see Figs. 2, 3, and 5), and are thus made a part of the main structure, reducing the lateral vibration of the upper chords to almost nothing, and equalizing the strain upon the longitudinal girders. The form of the "Standard" tie is simply a channel beam with the channel side up, the edges being cut away under each rail (see Fig. 1) in order that the rails will have no bearing on the sides of the tie, and to assist in keeping the rails from sliding sideways. Directly under the rail in the channel of the tie, and directly over each longitudinal girder, a creosoted oak block is placed with its grain vertical (see Fig. 3), and upon this block the rail rests, the block being sufficiently high to raise the rails clear of the depressions cut in the sides of the tie, so that no metal contact is had between the rails and tie.

The rail fastenings consist of a pair of steel spring clips (see *c*, Fig. 3), each of which is provided with two lugs, extending through the sides of the tie (see *g*, Figs. 1 and 3); the upper end of each clip is provided with a jaw, which slides over the upper surface of the rail base; a bolt is passed through each pair of clips and block under the rail sufficiently low in the block to avoid contact with the under side of the rail base, a nut is employed to draw the jaws (*e*) toward each other over the rail base, creating a seating and holding power which is very great. Actual tests show that the oak block on its end grain resists a pressure of 101 tons per square inch, without fracture or compression. If the character of the fastenings are taken into consideration, together with the resistance of the oak block and its foundation, and that the tie is riveted to the structure, it is obvious that the rail itself becomes a part of the main structure and cannot vibrate independently. Thus the rail is utilized to assist the structure to carry its load instead of being a dead weight.

The method of fastening the guard rails seems also to have been improved. Each guard rail is provided with two bolts to each tie instead of one, as formerly, and are also braced with steel plates on the outside for the same purpose.

The annoying features of loose rail joints rattling and making a noise every time a wheel passes is overcome by the adoption of the steel tie, as will be readily understood by referring to the drawing. Fig. 4 represents a perspective view of the broad joint tie, illustrated as the middle tie in Fig. 5. The clips in this tie are provided with two bolts instead of one, the tie is extra broad and the clips extra long, so that a large foundation for the ends of each rail to rest upon may be had, together with a powerful fastening to hold the ends solid and rigid upon their foundation. In order to guard against the possibility of the ends of the rail cutting down into the wood block and also from creeping, a steel plate (see *s*, Figs. 4 and 5) is provided which covers the upper surface of the block, the latter being shortened to provide for the thickness of the plate, which is provided with four lugs that engage with recesses in the side of the rail base to prevent the rail from creeping, provision having been made for contraction, etc.

The application of the "Standard" steel tie to the elevated road, it is expected, will reduce the noise in a very noticeable degree, and the track will be much more reliable and smoother to ride over; and it is claimed, also, that a very great saving will be shown in favor of the steel tie, confirming the excellent judgment of Col. Hain in adopting them.—*Eng. and Mining Journal.*

[THE MASTER MECHANIC.]

A THEORY OF THE STRAIGHT STACK.

As a starting point for this investigation, it is proposed to take a possible case in practice, and thereby obtain some data concerning the duty required of the open or straight stack.

Suppose a locomotive to be developing 300 horse power. The consumption of water to be 28 lb. per horse power. Evaporation, 7 lb. per pound of coal. There would be 8,400 lb. of water evaporated each hour, 140 lb. each minute, and 2⅓ lb. per second. As 1 lb. of water produces 26·36 cub. ft. of steam at atmospheric pressure, the exhaust steam would amount to 61·6 cub. ft. per second. It would issue from a 4 in. nozzle at a speed of about 700 feet per second, if it were a jet of uniform velocity.

The consumption of fuel would be 1,200 lb. per hour, 20 lb. per minute, ⅓ lb. per second. This would exhaust the oxygen from 50 cub. ft. of air per second. A larger quantity of air than this would be required, probably as much as one-half more, say 75 ft., as it is practically impossible to produce perfect combustion with the proportion of air required by theory.

The products of combustion, on reaching the smoke box, will have a temperature of about 700°, and will have about double the bulk of the air as it entered the ash pan; so there will be 150 cub. ft. of hot gases to be expelled through the stack per second. Add to this the exhaust steam, and we can safely count upon 211 cub. ft. of mixed steam and gases to be delivered from the top of the stack per second. If the top of the stack is 18 in. diameter, the speed of issue would be about 119 ft. per second.

The bulk of the exhaust steam as it leaves the nozzle will be to the bulk of the products of combustion, for a given time, nearly as 1 to 2½. The weight of matter ejected from the stack per second would be: steam 2⅓ lb., fuel ⅓ lb., air 5⅝ lb. = 8·48 lb. $8{\cdot}48 \times 119 = 1{,}009$.

Divide 1,009 by the weight of the steam, 2⅓, and we have 432 ft. per second as the speed which the steam current would require to enable it to impart a velocity of 119 ft. per second to the smoke box gases. This it would have if it were in the form of a column 5⅛ in. in diameter. It must of necessity be ejected from a nozzle smaller than this size, and at a higher velocity, as no allowance has been made for the force required to overcome friction, to produce the requisite amount of smoke box vacuum, etc.

For the same number of cubic feet per second of escaping gases, the speed will be inversely as the square of the diameter of the upper end of the stack. The less the velocity of the gases as they escape, the less power will be required for their expulsion.

The great velocity of the contents of the stack here shown gives the most convincing proof of the importance of giving it such a shape that it will present the least possible resistance to the currents passing through it, and at the same time give the greatest possible effect to the blast from the exhaust nozzle.

As gases follow the same laws as fluids when in motion, something can be learned by consulting a treatise on hydraulics, which can be easily applied to the designing of the straight stack. When water escapes from its containing vessel through a thin-edged circular orifice, the stream assumes a peculiar shape as it issues. At a point about one-half the diameter of the orifice from the point of escape, it is contracted to about four-fifths the diameter of the orifice, so that at this point the sectional area of the jet is only five-eighths that of the orifice (see Fig. 1). The velocity of the current will be nearly the same as though the water fell from a height equal to the distance from the surface of the water in the vessel to the center of the orifice, there being a slight loss from friction. The "theoretical discharge," as it is termed, is calculated by multiplying the area of the orifice by this velocity ($\sqrt{2GH}$). Calling this 100, the amount of water escaping from the thin-edged orifice is accordingly 62.

If the water escapes through a short cylindrical projecting tube with square ends, two or three diameters in length (see Fig. 2), the discharge will be increased from 62, as with Fig. 1, to 81. The water currents in entering the tube have a tendency to form the "contracted vein," and an eddy is produced which obstructs the flow. There is a very considerable relief of pressure in the tube just at the point where the eddy is found. If a small branch tube be inserted into the side of the other, at a distance of about one-half its diameter from the vessel, water may be raised from a lower level. If it is not lower than three-fourths of the height from the surface of the water to the center of the tube, it will rise to, and be carried away with, the flow from the vessel (Fig. 3).

If the tube be of about its diameter in length, with thin sides and squared ends, and it projects into the vessel, the jet will be so contracted that it will not touch the sides of the tube, and the discharge will be only 55 (see Fig. 4).

If this re-entrant tube is three diameters or more in length, the stream will fill it, and the discharge will be increased to about 71. This is considerably less than that from the projecting tube. The currents passing around the edge of the tube are thrown farther toward its center, and thus there is more of an eddy and more of an obstruction than when the current simply turns a right angle, as in Fig. 2.

The above examples show very plainly the influence which abrupt angles have upon the flow of liquids. Water is a heavy, inelastic fluid, and the effects above detailed are strongly marked. With air, which is lighter and very elastic, the effects are possibly less in degree, but undoubtedly the same in kind. That air currents have the same tendency to form the "contracted vein" is plainly shown by the way the flame creeps outward around the edge of the open fire door when the draught is strong.

If the outlet is made with a rounded outline, approximating that of the "contracted vein," and about five-eighths of the smaller diameter in length (see Fig. 5), the discharge will be nearly the theoretical quantity (about 97). If it now be prolonged into a flaring taper tube (Fig. 6), the flow will be increased, and with a properly proportioned tube, the discharge may be nearly doubled in amount.

The best results are attained with a taper about one inch to the foot, the length of the tube being ten times its smallest diameter. The tendency toward relief of pressure at the neck of the tube is in this case very strong, and a modification of this form is employed as a condenser for steam engines, the exhaust steam being admitted to the tube at its narrowest part. A 26 in. vacuum has been obtained in this way with a head of only 15 ft. to the condensing water. It is also employed in the arts for producing a partial vacuum. Used simply as a discharge tube, the flow may be as great as 180—more than double that from the short cylindrical tube with square ends (Fig. 2).

One curious fact in relation to this form of tube is that the amount of discharge depends, not upon the size of the neck, but *upon that of the outlet end.* Theoretically, the neck may be decreased in size without affecting the amount of discharge until the relief of pressure at this point amounts to a vacuum, and the stream breaks in consequence.

If the stack were merely an outlet through which the contents of the smoke box were to be discharged, under pressure, its form would be pretty clearly pointed out. As it discharges gases instead of fluids, some changes might be admissible. The taper of the outlet, in the example given (Fig. 6), is limited by the capacity of the escaping fluid to spread and fill the entire area of the tube. With an elastic gas, instead of a liquid, it is quite possible that a greater amount of taper could be used. Still it appears, by examining the most recently published sketches of stacks and front ends, that the amount given, 1 in. to the foot, corresponds with the usual practice.

The blast from the nozzle should be a strong, close current, central to the stack. Any form of nozzle which allows the jet to spread, or to go from side to side with the alternate exhausts, is so far defective.

As it passes upward, the jet carries with it the gases immediately surrounding it, and its exterior becomes mixed with them. The blast, and the current caused by it, will, therefore, take the shape of an inverted cone, its apex at the nozzle. The upward currents will be weak at the exterior of the cone and stronger as they lie nearer the center.

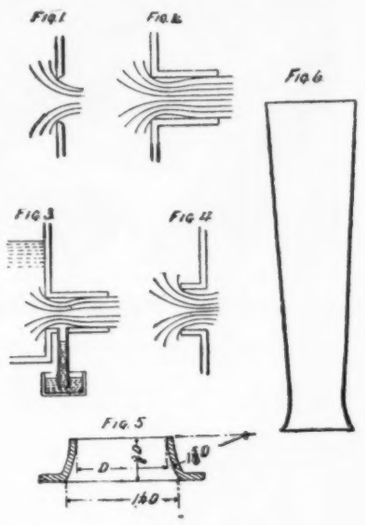
It is now the office of the stack to confine these currents, to diminish the area acted upon by the blast, so that its influence may be strongly and evenly felt throughout the ascending current. When we consider the conical shape of the current, it is plain that a cylindrical stack will be either too small at the top or else too large at the base. *The stack should take the form of the current which passes through it,* and not constrain it into a shape which it does not naturally assume. Any change of form forced upon the current can only result in a useless expenditure of force. Taking into consideration the influence of the blast upon the escaping gases, the general form of the stack through which they pass will remain the same as before—a taper tube with its small end presented to the nozzle.

It will be remembered that the relative bulk of the escaping steam and gases was stated as 1 to 2½ nearly. This would seem to indicate that the neck of the stack could be even smaller than it is usually made. The proportion between a 4½ in. nozzle and a 14 in. stack would be about 1 to 9⅝. The proper diameter remains a matter for experiment.

The entrance to the stack should be easy. The form of the "contracted vein" should be borne in mind in designing it, and it will probably operate better if made in two sections of different taper, to approximate the proper curve. It will be seen that the length of this section need only be about five-eighths of the diameter of the throat of the stack.

A long section for entrance takes away just so much from the upper section, and it would seem as though it would to just this extent diminish the efficiency of the blast, the effect of which is felt above, rather than below, the throat of the stack.

Owing to the limitation imposed by the necessity of keeping the top of the stack within a certain distance



from the rails, it is sometimes made very short, not more than three diameters in length. It might possibly be of advantage in such a case to place the nozzle lower, and extend the stack downward into the smoke arch. Another diameter could be easily added to its length in this manner.

Allowing the throat to remain the same diameter, the longer the stack is, the larger it can be made at its upper end, and the better effect the blast will exert.

If the stack is extended downward, the re-entrant tube (Fig. 4) should be borne in mind, and the entrance section should be extended by the addition of another member, so as to bring its flare out nearly to a horizontal line, so as to cut off the descending currents. It is scarcely possible to make the stack too long. The blast from the exhaust pipe will make itself felt through one of even six diameters in length.

If the foregoing instances have any bearing upon the subject, the matter may be summed up as follows:

The open stack should have a wide entrance section at its lower end, leading to a narrow neck; beyond which the stack should enlarge at a gradual taper as it extends upward. The lower section should be one diameter at its upper end, one and a quarter diameters at its lower end, and five-eighths of a diameter in height. Theoretically, it should have curved instead of straight or conical sides. The upper end of the lower section, being the smallest part of the stack, should be of a size which will allow the influence of the blast to be felt throughout its entire area. This point will be to some extent a matter of experiment, if the best results are desired for a particular case. As a conjecture, the diameter of the throat of the stack may be put at about four-fifths the diameter of the cylinder. The taper of the upper section of the stack will be at least one inch to the foot. Possibly, it may be greater, there not being sufficient data available to fix it positively. The greater it is, the better, if the influence of the blast is sufficiently felt throughout its area. The upper section should also be made as long as possible, there being an advantage in having a large diameter to the outlet end.

An open stack of a cylindrical form is a *mistake.* If it forms an abrupt juncture with the smoke arch, so much the worse.—*Geo. B. Snow.*

THE ORIGINAL BICYCLE.

WE have referred before to a machine made in about the year 1845, by Galvin Dalzell, a Scotchman. The cut herewith shows the machine and is a reproduction

from the *Scottish Cyclist.* The driver is 40 in. and the steerer 30, both iron shod. The general delicacy of the mud guard and frame work will be appreciated. It, however, is a most interesting relic.

A CALIFORNIA BANYAN TREE.—On the ornamental grounds of General Bidwell's residence at Chico, there is an immense fig tree, the branches of which have drooped to the ground and taken root, forming a large, densely shaded arbor.

THE PHILADELPHIA CARPET INDUSTRY.

THE Philadelphia *Press* gives the following interesting letter regarding the great industry of carpet manufacturing in that city:

The greatest single industry in Philadelphia, or indeed in any city in the world, is the manufacture of carpets. There are in this city now 172 establishments, occupying over two hundred large structures as factories, working 7,250 looms and employing 17,800 workmen. These forces produced in the aggregate during last year 72,000,000 yards of carpets, worth very nearly $48,000,000. The following summary has been prepared with great care from detailed statements of each establishment, and the extension of values, based on average prices and approved by the largest producers and dealers. The asterisks indicate hand looms:

	Power Looms.	Yards.	Value.
Ingrains	2,800	33,600,000	$16,800,000
*Ingrains	800	4,800,000	2,400,000
*Art squares	200	1,200,000	720,000
Brussels and Wilton	600	10,800,000	8,640,000
Tapestries	350	6,300,000	3,780,000
Damask Venetian	500	6,000,000	2,400,000
*Smyrna rugs and whole carpets	1,500	6,000,000	12,000,000
*Axminster velvets	100	300,000	600,000
*List, rag and chain	500	2,500,000	750,000
Totals	7,350	71,500,000	$48,090,000

Some intermediate varieties are necessarily merged in the more general classification, every variety known to the users of carpets being made in its full proportion, with an especial increase of rich rugs, double-faced and whole carpets during the past year.

The writer's knowledge of this industry dates from 1857, almost at the first of its development here, and he has taken each of the several national and local census enumerations of industries (1860, 1870, and 1880), with the city census of 1882-83. Observing closely the growth and condition of the mills on each occasion, it has been comparatively easy to preserve and perfect the record of them at intervals, until now they are found to be as summarized above.

This most remarkable development has taken place within thirty years. In 1857 the patriarch and founder, John Bromley, worked but two looms in one very small building, and his older sons two more in another small building. Now the mills of the three firms conducted by the Bromleys employ 2,800 workmen and 1,100 looms. The still more gigantic establishment of the Dobsons—but which only dates back to 1872—employs nearly 4,000 persons, because it conducts all the spinning, dyeing, and other processes. These works employ 500 power looms.

The importation of fine carpets, Brussels, tapestry, Wilton, etc., was universal down to 1870 and quite considerable until 1877, when the Dobsons' great product of fine carpets broke up importation altogether. At present no one thinks of any other carpets than those of domestic manufacture, and the finest velvets, Wiltons, Smyrna rugs and whole carpets known in the world are made here in Philadelphia. In these fine goods the Bromleys and Dobsons are now followed closely by eight or ten conspicuous establishments, and the splendid mills on and near Lehigh avenue, in the northern part of the city, are models of stately and artistic structures which we may infer naturally led the bankers of Fourth street and Chestnut street into the taste for better structures, such as they have now built. The carpet men were first on the carpet, in technical phrase, in erecting fine structures for business uses.

The germ of this great industry was planted at Fifth and Germantown road about 1845, as the directory for that year locates John Bromley there, "Rear of Fifth and Germantown road." For nearly fifteen years he remained at that locality, but in 1861 he removed to Front and Jasper streets, then a long distance out. At this later time the number of beginners in the ingrain manufacture was large, and all worked in the smallest places of shelter possible, generally in the rear of their own lots or dwellings. But no more intelligent, sturdy, and vigorous race of men ever lived than the founders of the carpet industry in Philadelphia. They held their ground against all difficulties and rapidly grew in strength, numerical and financial.

In 1860 no separate report of persons employed in the carpet industry appears in the census, and in 1870 only the State of Pennsylvania is distinguished, there being 4,941 persons so engaged. In 1880 the State had 8,885, and in 1883 the city separately had 11,000. The present number in the carpet mills in this city alone is 17,800, and the spinning and dyeing establishments necessarily connected with the materials used would give 5,000 more. By the usual rules of productive capacity for each person employed, it would employ 25,000 persons to produce $50,000,000 in value of any textile or metallurgic fabric.

The largest production is of ingrains—a fabric capable of being made very durable and useful. It is, therefore, more largely sold than any other. Until the last two or three years ingrains were made wholly on hand looms, but now there are 2,800 new power looms in use here, doubling the product possible from hand looms and making 12,000 yards each loom yearly, and with the broad ingrained or art squares aggregating 20,000,000 square yards. The next great product is of Brussels and tapestries, there being 1,000 power looms on these, with a product of 17,000,000 yards.

The third in order is the Smyrna and other rugs and whole carpets, all now made of the richest materials and in the most perfect manner, but almost wholly on hand looms. There are 1,500 of these looms, many of them very wide, of which the Bromleys work fully half. The product is more than six million square yards, worth $12,000,000. Axminsters and moquettes are made by Dobsons, velvets by Dobson and others, Wiltons by all body Brussels makers, of whom there are sixteen in all, working 600 power looms. Tapestry Brussels are made by half of these Brussels mills, using 350 power looms. Damask and Venetian floor and stair carpets are made by fifteen different mills, working 500 looms in all. Rag, net, and chain carpets, as they are called, are made by about thirty establishments, some of them well equipped and producing fabrics of standard value and using fully 500 hand looms.

The great body of the carpet mills is in western Kensington, a part of the city which has been built up

in wealth by them, and which is beautiful as well, with fine broad streets, tasteful dwellings, and really magnicent structures as mills. Its local business growth is so great that there are fine shopping streets, rivaling those of the old city. Its schools, churches, and public structures are in keeping with the rest, and the fine Episcopal Hospital crowns the elevation on Lehigh Avenue. Should any madness dismember the city this greater Kensington could undoubtedly maintain an independent government, and not miss Chestnut street.

LORIN BLODGET.

Philadelphia, January 24.

THE MANUFACTURE OF NITRO-GLYCERINE.*

THE manufacture of nitro-glycerine, like that of dynamite, was commenced about twenty years ago, but no detailed description of the process has, so far as we are aware, ever been published. Most of the works on the subject describe simply the work carried on in laboratories or give simply an outline or incomplete description of the methods employed in the large factories of this or the other hemisphere.

What is nitro-glycerine? It is necessary that our readers should understand what it is before we describe its manufacture. Nitro-glycerine is obtained by the reaction of nitric acid upon glycerine expressed in the following formula:

$$\underbrace{C_6H_5(H_3O_3)_3}_{\text{glycerine}} + \underbrace{3(AzO_6H)}_{\text{nitric acid}} = \underbrace{C_6H_5(AzO_6H)_3}_{\text{nitro-glycerine}} + \underbrace{3(H_2O_2)}_{\text{water}}$$

Besides nitro-glycerine, obtained by replacing three parts of water of glycerine with three parts of nitric acid, there is, as may be observed, a residue of water, which is absorbed by the addition of sulphuric acid. In short, the three ingredients employed in the production of nitro-glycerine are glycerine, nitric acid, and sulphuric acid.

The apparatus that we are going to describe is designed to treat the above substances in comparatively large quantities. Each apparatus produces about 100 kilogrammes of explosive in one-half hour of treatment. Fig. 1 gives a sectional view of apparatus, Fig. 2 one

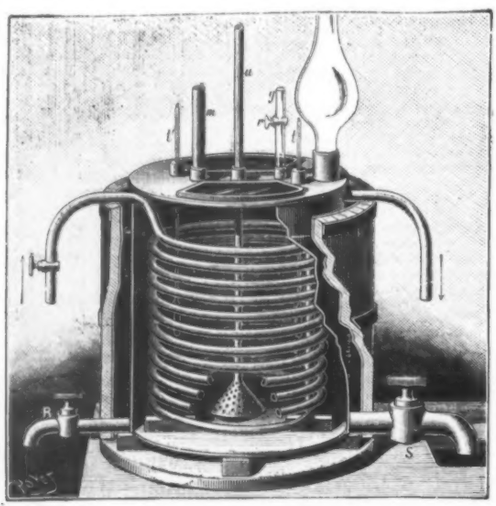


FIG. 1.—APPARATUS USED IN THE MANUFACTURE OF NITRO-GLYCERINE.

of the shops in which it is located, and Fig. 3 a general view of the works at Cengio, Italy. Before passing on to a detailed description of the manufacture, it would be well perhaps to treat the subject for a moment on a small scale and to prepare, if you please, on our laboratory table (see Fig. 4) a single kilogramme of the explosive. The elementary operations which we shall make

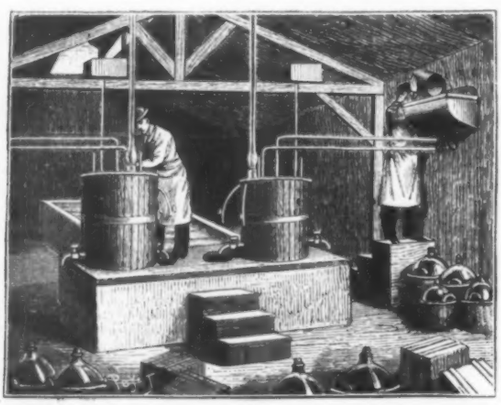


FIG. 2.—SHOP IN WHICH THE NITRO-GLYCERINE IS PREPARED.

are carried on, only on a larger scale, in the general manufacture.

We begin by combining in a cylindrical glass vase (Fig. 4) 1·5 kilogrammes of nitric acid at 48° and 3 kilogrammes of sulphuric acid at 66°. This is allowed to cool after having been thoroughly stirred with a glass rod. This vase is placed within a larger vase of cold water and 500 grains of glycerine at 30° is permitted to fall, drop by drop, into the liquid, which is constantly stirred. The reaction takes place as soon as the glycerine is introduced, and the nitro-glycerine is found at the bottom of the vase in a thick, white mass. The excess of acid is then drawn off, and that which remains at the bottom is washed first in water and then in carbonate of soda until turnsol paper no longer changes color. The nitro-glycerine thus obtained has passed through all the processes employed in the general manufacture; *preparation* of the mixture of the two chemicals; the chemical *reaction* of the glycerine upon this mixture and the *formation* of the nitro-glycerine; the *separation* of the excess of the acid; and finally the washing of the nitro-glycerine under a running stream, and carbonate of soda for its thorough neutralization. The operations are without special danger to those who are experienced in the handling of high explosives.

Let us examine now the manufacture of this substance, which will be readily understood if the principal points in the process that we have described are borne in mind. The processes we are now going to describe are those which have been employed during the past few years at the factory at Cengio, Italy. At the

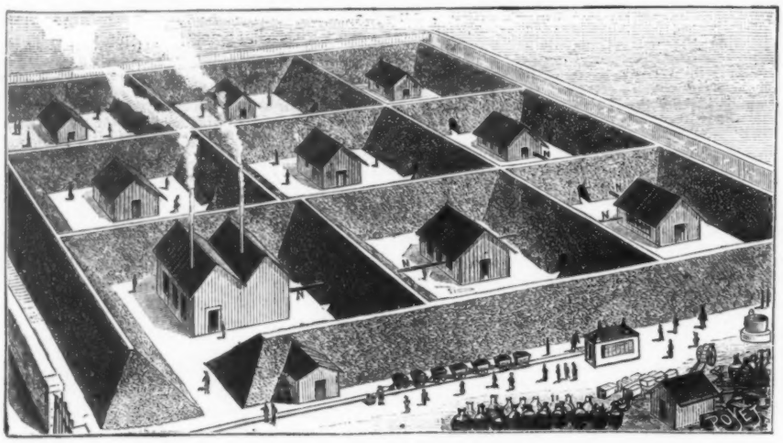


FIG. 3.—GENERAL VIEW OF THE NITRO-GLYCERINE WORKS AT CENGIO, ITALY.

beginning we admit that there are apparatus that are more complicated, more remarkable, owing to their expensive and elaborate detail, but it is doubtful if any are more remunerative than the type we are going to describe. In the most elaborate plants the product does not exceed 200 of nitro-glycerine from 100 of the crude glycerine, which are the results obtained at the factory we have taken as a type.

Let us pass through the entrance of the "explosive" factory, thus denominated because detonating substances are here manufactured which have sometimes a trick of "going off" of their own accord. I would like, however, to state that during the five years I conducted the manufactory at Cengio, during which period 500,000 kilogrammes of dynamite was produced, there was not a single explosion and not one victim—a remarkable record. Let us examine first the two principal machines used in the manufacture of glycerine—the pump which supplies a stream of water for the different processes, and the air compressor which furnishes the compressed air used in mixing the liquids. Owing to the fact that nitro-glycerine congeals at a temperature of some 8°, 9°, or 10° above the freezing point, the slightest coldness necessitates the heating of the workshops, which is accomplished by introducing pipes from a furnace located outside of the general inclosure. The apparatus includes therefore (see Fig. 3) the water and compressed air pipes and steam pipes which are laid on the top of the bastions. The workshops are surrounded by powerful earthworks. In the first shop, the most important, the chemical reaction of the glycerine upon the mixture of nitric and sulphuric acids is carried on, which process was described on a small scale above. Here are four apparatus simi-

FIG. 4.—PREPARING THE EXPLOSIVE IN THE LABORATORY.

lar to that illustrated in Fig. 1. Each will produce 100 kilogrammes of nitro-glycerine each half hour, the total production corresponding with the daily mean production of dynamite in the factory. The apparatus (Fig. 1) consists of a cylinder of staves firmly held together by strong bands and having an interior jacket of lead which is not affected by the action of the sulphuric and nitric acids. The cylinder is about three feet high and not quite as wide, and has a capacity of 500 liters. The desired amount of the mixed acids is delivered into this cylinder through a lead pipe connecting with the heaters, where the acid preparation is made, generally about 300 kilogrammes of sulphuric acid being mixed with 150 of nitric acid. After they are mixed thoroughly, about 50 kilogrammes of glycerine is introduced drop by drop. The chemical reaction, which is indicated by the rise in temperature, stops with the introduction of the glycerine; the reaction is maintained by a jet of compressed air which agitates the liquid, and it is cooled by cold water passed through a coil. The entire operation is completed in half an hour, with the results as above stated. The nitro-glycerine, which is still mixed with the acid, needs now only to be separated therefrom and washed and neutralized. Perhaps nothing is more curious, or more thoroughly impresses the spectator,

* By M. Vuillaume, late director of the dynamite manufactory at Cengio, Italy.—From *La Nature*.

whom acquaintance with the business has not rendered insensible to violent emotions, than to behold, through the windows in sides of the apparatus, the yellow mixture boiling and bubbling like a torrent during a freshet and possessing the energy of the greatest projectiles, and which might, at any moment, explode and reduce everything about it to powder, while there is nothing to indicate the terrible destruction that the vessel contains, nothing escaping through the glass safety valve save a light red vapor.

How often, with my eye fixed on the thermometer as it was gradually rising, have I thought that a simple pressure of the finger on the valve which regulates the flow of the glycerine, and as a result the chemical reaction would be the signal for a horrible and destructive disaster. Look at the placidity of the workman, however, who, with his nose in the vapors and his mind, perhaps, elsewhere, mechanically watches the reaction with his foot on a volcano—in the grave. While he is dreaming of the next pay day, of his *fiancee*, who, perhaps, only one or two shops from there, is packing dynamite, or of the bottle of wine he will drink after the work is over, the apparatus is continuing its work of producing 100 kilogrammes of nitro-glycerine every half hour. Two machines can produce, in four hours, allowing for the time required for emptying and cleaning, the 700 or 800 kilogrammes of nitro-glycerine that are necessary for the daily production of 1,000 kilogrammes of dynamite, at 75 for each 100 of nitro-glycerine and other absorbents.

Next comes the purifying of the glycerine. The impure nitro-glycerine is first to be separated from the acids, which will be separated from one another afterward, then thoroughly washed to remove any acid that may remain, and finally neutralized in a bath of carbonate of soda.

There is certainly nothing extraordinary or secret in this. If there is any secret, it consists in the danger involved, which imposes implacable rules; but the process makes use of simply the ordinary laws of chemistry. Whoever can work with prudence, and cautiously follows the laws of chemical reaction, will discover the famous secret. This may not be very easy, but it is not impossible.

From the shop where it is prepared, the glycerine, still impure and mixed with an excess of acid, is taken to the shop where it is separated. Being light, it rises to the surface in the large lead cylinder, nearly three feet high and over two wide, whence it is poured into a pipe and transferred by a stream of cold water in summer and warm water in winter to the washing shop. Here it is received in tanks filled with water, and a jet of compressed air aids in the process of separating the nitro-glycerine.

When the explosive is removed from the tank, the process is practically finished. Nevertheless, it is then poured into another tank containing a solution of soda, where it is thoroughly agitated by a jet of compressed air. Then the nitro-glycerine, pure and having no effect upon turnsol, is ready for the manufacturing processes. It is transferred from the washing room into the room where it is mixed with absorbents and is transformed into dynamite. It is then packed into zinc cylinders partly filled with water, and then gradually filtered into felt tubes for removing any traces of water that may remain.

Such, in general, is the manufacture of nitro-glycerine. The methods of separation and washing may be greatly varied. We believe it is preferable to conduct the work in separate shops, as is done at Cengio, thus reducing the chance of what is always, in spite of every precaution, to be apprehended, a general explosion. Besides, the shops are not far enough apart (about 60 feet apart, including the bastion) to embarrass the efficiency of the work.

Should any reader visit any of the works in France, either Paulilles, or Ablon, or Cugny, and if he succeeds in getting permission to examine them (for those engaged in this business are suspicious), he will find the conditions very similar to those described above. Here is a word of advice—look, but touch not, and do not even look too long. Anybody who is not accustomed to it will probably be afflicted afterward with a terrible neuralgia, due to effect of the vapors upon the organism. This intoxication, for which no remedy has been found, is one of the most curious and embarrassing phenomena connected with the manufacture of nitro-glycerine, and it seemed to me that this article would not be quite complete without referring to it.

MACHINE FOR COMPRESSING COAL DUST.

THE first agglomerate of coal that was made was in the form of a ball, which was moulded by hand. The first mechanical device for effecting the operation was suggested by the small apparatus that has long been used by pastry cooks for making balls of sugar. This apparatus consists of two cylinders, one arranged above the other, between two checks carrying bearings with adjusting screws. The upper cylinder, which is moved by a winch, actuates the other through tangential gearings. These two rollers contain hemispherical depressions that exactly correspond, and the paste that is pressed between them is moulded into balls. The machine for making ovoid balls of coal is nothing more than this apparatus enlarged. The agglutinants used for forming the coal into a mass—tar, clay, etc.,—prevented its success in the first place. Still, it continued to be constructed on the same principle, with the addition of small spring plates at the bottom of the moulds to eject the agglomerate. As these were discovered to be useless where pitch was used as an agglutinant, they were discarded, and the apparatus then became very simple and practical. One trouble remained, however, and that was that the tangential gearings, upon becoming worn, displaced the halves of the moulds, which, no longer corresponding accurately, formed a seam on the balls.

This inconvenience is very simply and happily obviated in the apparatus devised by Mr. Fouquemberg. This consists of two rollers revolving against one another and covered symmetrically with half moulds arranged like cells. The half moulds of one roller coincide exactly, at the line of contact, with those of the other. The balls escape through the rotation of the cylinders, and through the effect of their weight alone.

The apparatus is driven through two pulleys upon a shaft provided with two endless screws that move, in an opposite direction, two helicoidal gearings keyed upon the shafts of the cylinders.

The shaft that carries the two endless screws is capable of being shifted longitudinally. The two helicoidal gearings are therefore actuated separately, and revolve in opposite directions.

When the screws and gearings have the same hardness, the screws moving in opposite directions wear equally, and the half moulds of the two rollers are prevented from getting out of true. But if the screws and helicoidal wheels wear unequally, it requires but a simple longitudinal shifting of the screw shaft to bring back the half moulds to perfect correspondence. In fact, when the shaft is moved longitudinally from right

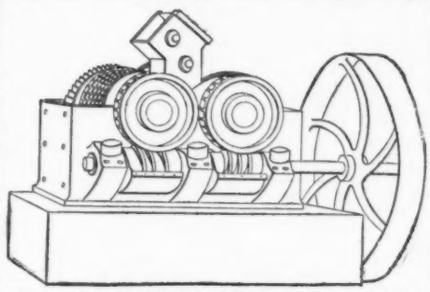


FIG. 1.—MACHINE FOR COMPRESSING COAL DUST.

to left, the endless screws revolve the helicoidal wheels in the direction, *f*, shown by the arrows in Fig. 2. The cylinders then follow this direction, and the half moulds, *o* and *h*, separate from each other. When the shaft is moved in the other direction, the moulds come together again.

It is evident that there is a point at which these half moulds correspond exactly, and this point is shown by a datum mark externally to the cylinders. The shaft is regulated by two counter points, *b b*, and two rings with adjusting screws, *d d*, keep it in place while running.

The endless screws also greatly simplify the transmission of motion to the rollers, which make four revolutions and a half while the screws are making a hundred. In order to obtain the same reduction of velocity with ordinary gearings, it would be necessary to multiply them.

This simplification of motion has permitted of grouping all the parts of this apparatus upon a frame of the greatest stability and of thus making it a compact tool that can be shipped all ready mounted.

The endless screws run constantly in it, and are of cast steel, as are also the helicoidal wheels. If it be considered that the method of regulating permits of their wearing up to their limit of resistance, it will be conceived that they will last for a long time. These screws and wheels are covered with an iron plate jacket, which preserves them from dust and prevents the operator from meeting with accident.

The pillow blocks that receive the shafts of the moulding cylinders are so arranged as to permit of remedying the wear of the bearings through adjusting screws and of keeping the rollers constantly at the proper distance apart.

The paste, which comes very hot from the kneading machine, when superheated steam is used for economizing the pitch, would, although delivered to the apparatus by an Archimedean screw, heat the cylinders too much and render it difficult to empty the moulds, were the cylinders not hollow, so as to allow of a circulation of water in them. By means of these cylinders it is possible to make masses of any form of revolution, but the ovoid shape is the one already sanctioned by usage. Hollow balls also may be made, but it is by means of a complication that may be avoided by making the ball thinner. Moreover, in fireplaces these small agglomerates, owing to their rounded form, have between them

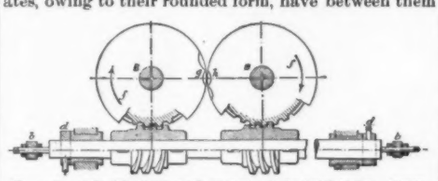


FIG. 2.—SECTION OF THE CYLINDERS AND MOULDS.

but few points of contact and leave sufficient space to render it unnecessary to perforate them.

This form of agglomerate permits of burning very bad coal. The shape has many advantages: the agglomerates can be put into cars automatically or by shovel, there is no waste during carriage, and their small dimensions adapt them, without preparation, to any fireplace.—*Revue Industrielle.*

MANUFACTURE OF CHLORIDE OF LIME.

By R. HASENCLEVER, Aachen, Germany.

CONSISTS of an apparatus for subjecting the lime to the continuous action of chlorine, and the principle on which it works is that the lime is turned over and fed from one chamber to another in the opposite direction to that which is pursued by the current of gas. The same apparatus is equally applicable for conducting a similar process with different materials. Figs. 1 and 2 represent a cross section and a sectional side view respectively. Four pipes, A B C D, are arranged one above the other, and each tube contains a propelling apparatus, which consists of a number of blades, U, upon the horizontal shafts, T. The ends of the shafts project through the sides of the pipes, and they are geared together by the spur gearing, V, which is driven from the shaft, X. The gearing may be disconnected from the driving shaft by the withdrawal of the pin, X^1, which couples the worm wheel, W, and the first wheel, V, together. The lime is charged into one end of the tube, A, through the hopper, E, and it is caused to travel to the other end, from whence it falls down the branch pipe, F, into the second of the tubes, and so on until it is finally discharged down the shoot, I. The chlorine gas enters the lowest tube, D, through a lateral inlet, K, and it passes along the series of tubes until it arrives at the other end at O. It is preferable to have the communicating pipes, L M N, for the gas separate from the branches through which the lime passes, so that the dust of the lime shall not be carried along with the gas. In passing round the stirring blades, the chlorine comes into very intimate contact with the lime, and the absorption of the gas is thus effected

FIG. 1.

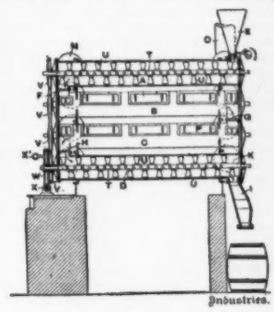


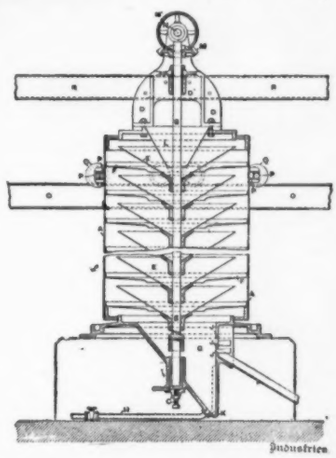
FIG. 2.

with comparative ease. Two claims are made for this apparatus, consisting of the series of closed tubes, through which the lime is passed in one direction by stirrers, and the chlorine in the other direction.

EXTRACTION OF GOLD FROM ORES.

By T. R. JORDAN.

FOR the purposes of extracting gold and other precious metals from their ores by the process of amalgamation, the inventor has designed the apparatus which is illustrated in the accompanying figure. A cylindrical vessel, A, is erected with its axis vertical, and a shaft, B, is mounted within it, so as to coincide with the axis. A series of inverted conical troughs, E, are attached to the vertical shaft, and a number of slightly inclined perforated troughs, F, are arranged upon the side of the casing alternately with the cones. The inner surfaces of the troughs, E, are covered with amalgamated copper plates, and the inclined plates, F, are made of copper. At the top of the vessel there is a hopper, L, through which the pulverized material is introduced, together with a supply of water. The axis and the inverted cones are then rotated by the gearing, M N, and the material is thereby caused to fly outward up the inclined surface of the cone. When the centrifugal action has brought the material to the upper edge of the cone, it falls over on to the plate, F, which directs



it into the succeeding vessel, E, where the process is repeated. As the water and ore pass over the amalgamated plates the particles of precious metal adhere to the mercury, and are thus intercepted. At the lower end of the casing, A, there is a concentrating well, G, which is in the shape of a wedge. A pipe, H, is introduced at the bottom of the well for the admittance of a stream of water when desired, and at the top of the well there are a number of outlet passages, J, at different levels. The mercury stand pipe, K, rises to a sufficient height to prevent any discharge when it is vertical. The casing, A, is preferably made in two halves, which are separately supported on wheels upon the side rails, O, by means of a frame formed of the axles, P, and tie bars, P^1. The hopper, L, and frame, D, are carried on the girder, R. By this arrangement the interior of the apparatus may be easily approached when it is necessary to extract the mercury and gold.

COLD PREPARED EXTRACTS.

THE idea of concentrating watery solutions by freezing is not a new one by any means. But hitherto the process has for various reasons only been applied on a small scale. M. L. A. Adrian, in a paper read before the Paris Chemical Society, now describes a method based upon the same principle of crystallizing out the water, whereby pharmaceutical extracts can be readily prepared in large quantities with scarcely any heat being applied. The defects of the former processes—Herrara's, for instance—are that (1) barely more than 60 per cent. of the water is removed by freezing, and (2) the ice separated contains 10 to 20 per cent. of the active principles, be the pressure ever so powerful. M.

Adrian proceeds differently. Instead of partly freezing the extractive solutions, as Herrara did, he submits them to a temperature of —20° C. (4° Fahr. below zero) in an ammonia ice apparatus, and thus obtains solid blocks having an average temperature of —10° C., and consequently very hard and brittle. The blocks are next passed through a peculiar shaving machine, where in less than one minute they are turned into snow, and the snow is transferred to a centrifugal extractor, which in barely twenty minutes separates out about 75 per cent. of the water and but very little of the active principles.

The concentrated liquid being once more treated in the same manner, only at a still lower temperature, a sirupy liquor is obtained, which is concentrated enough to rapidly afford in vacuo a solid extract, without raising the temperature above 30° C. (86° F.) Experience has demonstrated that a third freezing would be useless, if not worse, as it is wasteful, and might injure the active principles. The solid extracts obtained by the foregoing process, as compared with those prepared in vacuo or by open air evaporation, are very light colored, afford almost clear solutions with cold water, and present in a high degree the odor and taste of the drug, without that familiar flavor of fire. The difference is especially noticeable in respect to inspissated juices of fresh plants, as in their case the vegetable albumen is not coagulated. Another point worthy of consideration is that the cold process extracts will probably prove more active than the old style preparations. Hence it is not useless to ascertain the comparative therapeutic values of such extracts as belladonna or henbane, for instance, which are at the same time poisonous and more readily estimated. M. Adrian proposes in a coming communication to examine this side of the question.

ELECTRIC TRACTION ON TRAMWAY AND BY ACCUMULATORS.

THE experiments on electric traction tried in 1881 by Mr. S. Philippart are now being resumed with serious promises of success by the Philippart Brothers, who have the exclusive proprietorship of the Faure, Sellon, Volckmar accumulators in France.

The first car has been arranged. The general form that has been given it is doubtless not free from imperfections, if we consider that the storage of the accumulator boxes in superposed compartments has the grave inconvenience of raising the center of gravity of the car and of affecting its stability. Let us hasten to add that this defect has not proved much of an embarrassment, and that the ease of rolling is not affected by it. However, other cars are being constructed which will doubtless be not at all liable to reproaches of this kind.

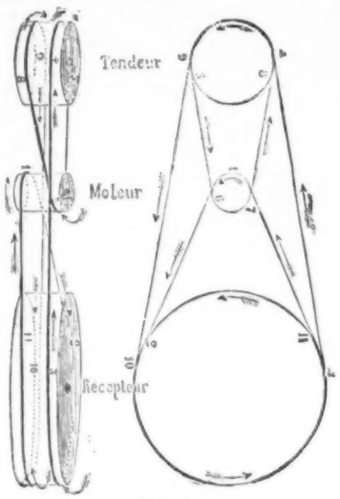


FIG. 6.

As it is, the car that is doing service between Place de l'Etoile and the Maillot gate, a distance of about 5,000 ft., has a total weight of 13,288 lb., distributed as follows:

Car	7,700 lb.
Accumulators	3,960 "
Electric motor	770 "
Transmission, etc.	660 "
Commutator, galvanometer, and accessories	110 "
Tools	88 "
Total	13,288 "

Fully loaded, it carries fifty passengers, weighing, on an average, 144 lb., say 7,200 lb. The actual weight then amounts to 20,988 lb.

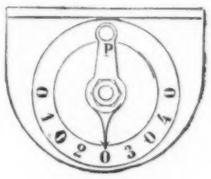


FIG. 7.

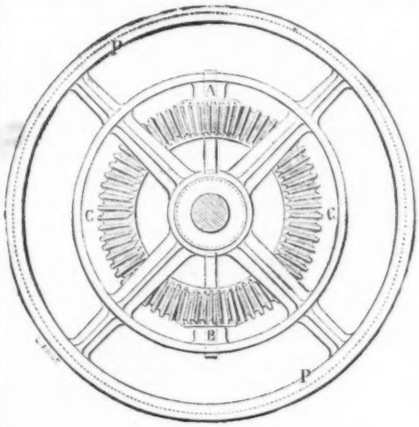
Fig. 1 gives a perspective view of it. The accumulators are arranged vertically in four compartments, situated in the corners of the car body.

The plates of the accumulators are of the movable twin model (Fig. 2), in which soldering is done away with, as well as junctions and all the troubles to which the latter are exposed. The electrodes are made in pairs composed of a positive and negative, connected by a bridge made of an alloy of lead and antimony. The mounting in twin plates possesses advantages that are very appreciable in practice. The plates are separated from each other, and kept at a constant distance apart by glass rods in the form of forks.

The source of electric energy is contained in 144 accumulators, each weighing 27,500 lb., mounted in twelve boxes, each containing twelve couples, in series. There are eight boxes in the rear compartments of the car, and four in the two front compartments.

The accumulator boxes are provided with metallic bars that automatically establish electric communications by the simple superposition of them upon similar bars fixed permanently in the closets. Commutators within permit of uniting the boxes by threes in series in order to constitute four groups of thirty-six accumulators.

The accumulators have an electric capacity of 150 amperes-hour. Estimating the mean electromotive force useful in the discharge at 1·8 volt, we reach a total capacity of 3,900 watts-hour, say 50 h. p. In practice we can scarcely count upon more than 40 h. p., with which a service of six hours' real operation is possible without recharging the elements.



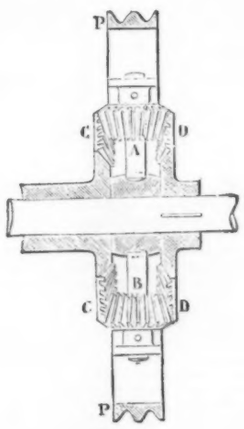


FIG. 8.

Figs. 4 and 5 give respectively an elevation and plan view of the frame, with the various arrangements adopted for the mechanism of locomotion. The forecarriage is movable around the joint, O (Fig. 5), and its motion is controlled by a hand wheel, A, within reach of the conductor's hand, and the axis of which is pro-

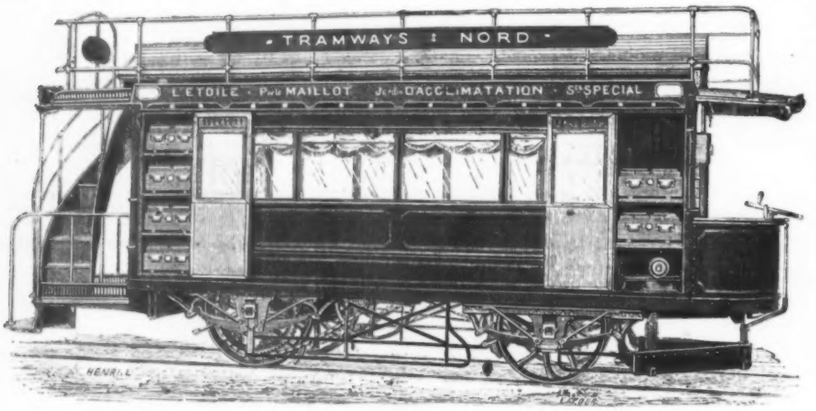


FIG. 1.

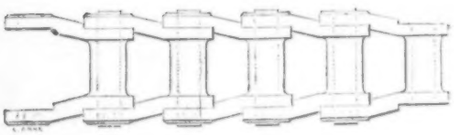


FIG. 3.

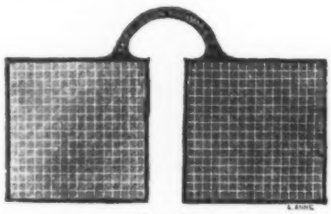


FIG. 2.

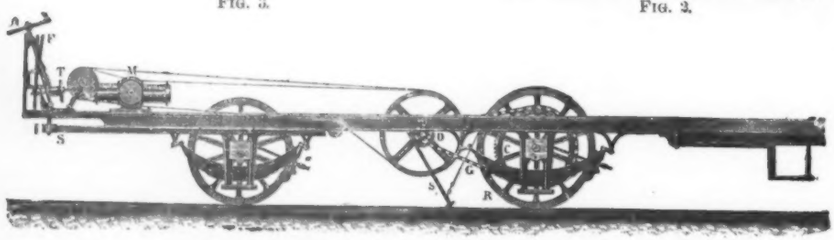


FIG. 4.

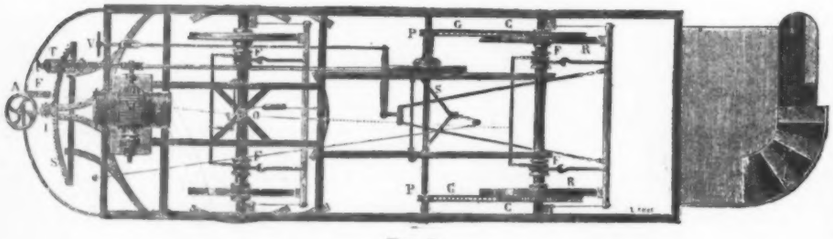


FIG. 5.

FRENCH ELECTRIC TRAMWAYS

vided with a pinion, I, that gears with a toothed sector, S. A vertical needle follows the motion of this sector, and its direction should always remain in the axis of the road. It is according to this that the engineman governs the evolutions of his car.

The motor, M, is a Siemens dynamo-electric machine, solidly fixed upon two cross pieces, where it cannot be touched by the passengers, but where it is under the direct inspection of the engineman. The armature revolves at an angular velocity of from 1,000 to 1,600 revolutions.

The dynamo communicates its motion to an intermediate shaft, P, by means of a transmission of the Raffard system, shown diagramatically in Fig. 6. This ingenious system is well known. It consists of an endless cord running over three pulleys—the motor pulley, a tautening pulley, and a guide pulley. An examination of the figure will render the advantage of this mechanical arrangement evident. In fact, the equal and contrary tensions exerted upon the axis of the motor are balanced, and pressures are, therefore, produced only on the bearings of the guide and tautening pulleys, where the angular velocities are notably less. The tautening pulley is provided with a device, T, by means of which the tension on the cord is regulated.

It is well known that every vehicle suspended upon springs is subject to oscillations of very variable amplitude. The connections of the driving axle with the intermediate shaft should, for this reason, possess a certain flexibility. In the present case, such flexibility is assured by the use of two pitch chains, G, a portion of the links of which is seen in Fig. 3. The pinions that actuate the chains are moved by an epicycloidal train, whose details are seen in Fig. 8.

The guide pulley, P, is loose upon its axle. Its hub carries the axles of two opposite bevel pinions, A and B, which gear with two wheels, one of which, D, is keyed upon the guide shaft, while the other, C, is loose upon the same shaft. The first of these wheels and the pinion to the left are interdependent, as are the second and the pinion to the right. The object of this arrangement is to permit the wheels, C and D, to take on different velocities in order to pass curves of feeble radius without slipping or sliding.

Upon a rectangular track, the two wheels of the driving axle make, in the same time, the same number of revolutions, and it follows that the two pinions, A and B, are immovable upon their axle, and render interdependent the two wheels with which they gear without revolving upon themselves. The actions upon the two pinions are equal and opposite.

On the contrary, on a curve, one of the driving wheels runs more slowly than its mate, and reacts with more energy upon the corresponding bevel wheel. The two bevel pinions cede on this side, begin to revolve, and hasten the rotary motion of the other toothed wheel, and consequently of the driving wheel that it carries along. This differential train is therefore of undoubted utility.

The Lemoine system of brakes has been adopted upon the electric tramway. These are maneuvered from the front platform by a lever, F, which is actuated by a hand wheel, V. Moreover, to make assurance doubly sure, shoe brakes also are provided.

When a car is obliged to stop upon an acclivity, the conductor lets fall the recoil brake, S, which holds the vehicle in place. A cord serves to lift this brake, which falls by its own weight. The conductor has to maneuver various parts in order to drive and manage his machine. In the first place, he must be able to reverse the machine, so as to run backward. To this effect, the dynamo collector is provided with two brushes arranged in the shape of a V. A single branch of the V is in contact with this collector. By acting upon a lever, the double brushes are made to tilt, and it results that the pair which was in connection is separated and the two branches of the other pair then bear upon the collector according to two generatrices situated at 90 degrees from the first position. The change introduced into the magnetic distribution gives rise to a reversal of the machine.

The exigences of the service necessitate variable systems of work. The different couplings of the elements corresponding to such variable systems are operated by means of a special commutator, which changes the effective electro-motive force of the battery. It consists of a wooden cylinder mounted upon a vertical axis terminating in a handle, P, provided with a needle (Fig. 7), which moves over a dial on which figures are engraved. Figs. 9 to 13 show vertical sections made at the various positions occupied by the cylinder. In the side of the latter are inserted, parallel with the generatrices, contact bars connected transversely, without, however, forming a contact with the axis of the cylinder.

The four groups of 36 accumulators spoken of above are coupled in four different ways, to wit:

1. The four groups are coupled for quantity, giving an E. M. F. of 70 volts.
2. The four groups are coupled two in series and two for quantity, with an E. M. F. of 140 volts.
3. The four groups are connected in threes for tension, the fourth being for quantity upon one of the three others, E. M. F. 210 volts.
4. Finally, the four groups are all mounted for tension, E. M. F. 280 volts.

The positive and negative poles of the four elementary batteries are respectively in connection with 8 brushes, designated by the letters B in Figs. 9 to 13. A passage is made from one coupling to the next by a breakage of all the contacts, shown by the positions, O, upon the dial (Fig. 7).

On examining the diagram of the third combination, we readily see that a group of two batteries mounted for quantity will discharge more than the group of two mounted for tension. In order to remedy this inconvenience, intermediate auxiliary commutators permit of inserting the batteries so as to make them operate by turns in the same conditions. The transposition appears in the position 3 *bis*.

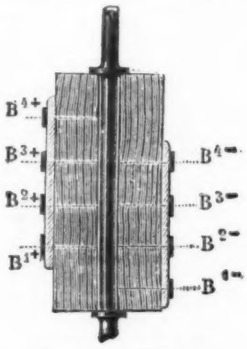


FIG. 9.—POSITION 1

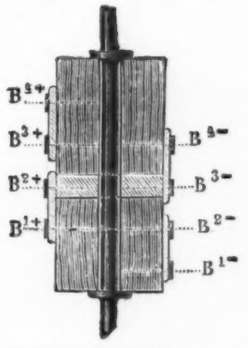


FIG. 10.—POSITION 2.

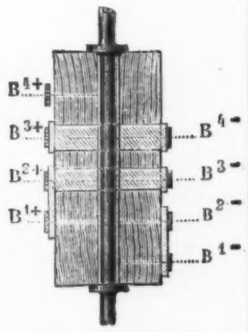


FIG. 11.—POSITION 3.

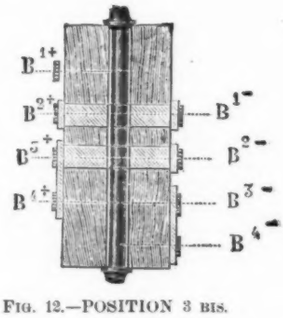


FIG. 12.—POSITION 3 BIS.

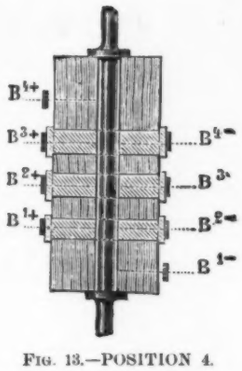


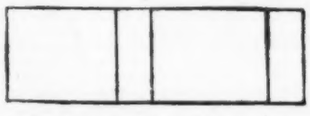
FIG. 13.—POSITION 4.

Finally, we shall have brought into prominence the principal characters of this car when we have said that the lighting is generally done by electricity. Three ten-candle incandescent lamps light the interior, and two light the front platform, one of these serving likewise to illuminate the roadway ahead.

On the rear platform there is one lamp. Lamps distributed along different parts of the frame throw light in case of need upon the various parts of the locomotive mechanism.—*La Lumiere Electrique.*

BATTERY CELLS MADE OF PAPER.

TAKE a sheet of good millboard or brown pasteboard. Cut lines with a sharp penknife so as to be able to bend the pasteboard into the shape of the cell, with the fewest possible pieces cut out, as shown by the lines below.



Fold over at the cuts, so as to make the cell without a bottom. Now take a piece of calico a little wider than the cell, and long enough to go a little more than once round. Make some good thin glue, glue the calico all round the outside of the cell, pulling very tightly, and leaving a little excess of calico below. Now cut a piece of pasteboard to fit truly in the cell, as a bottom. Glue it in and turn the excess of calico over it to hold it firmly in place, using fresh glue if necessary. When quite dry, boil in melted paraffin wax until no more bubbles are given off; then take out and stand on a damped slate, on its bottom, till quite cold.—*S. Bottone, in Eng. Mechanic.*

[From the JOURNAL OF COMPARATIVE MEDICINE AND SURGERY.]

RABIES.*

By RUSH SHIPPEN HUIDEKOPER, M.D., Vet., Professor of Veterinary Anatomy and Pathology.

GENTLEMEN: I take this opportunity of making some remarks upon hydrophobia in view of the fact that the disease has existed in an almost epizootic form during the past two months, in view of the importance of the subject, and of the absolutely false ideas which prevail in the popular mind in regard to hydrophobia, which has led to the definite statements and the expressed belief, on the part of reputable physicians, that no such disease exists, simply because they have not seen cases, and because the cases are so excessively varied in their symptoms and their course. The disease is subtile and the symptoms of derangement of the highly organized nervous system may be different in different cases. In one case there may be excitability, in another depression, while in others there may be alternating conditions of anæsthesia and hyperæsthesia involving both the central nervous system, the two sets of peripheral nerves, the motor and sensory, and the sympathetic system. In view of these considerations, I thought it advisable to take up the consideration of this disease out of the regular course where it belongs, that is, with the contagious diseases.

I shall in the beginning adopt one of the synonyms in place of the more common term of hydrophobia. I prefer the name rabies, meaning to be mad. We have as synonyms *hydrophobia*, the fear of water; again madness, in the Greek, *lyssa*; in the German *hundswuth* or *tollwuth*, in Italian *rabbia*, in French *la rage*, in Spanish *rabia*. In addition we have in all languages the term hydrophobia, the fear of water.

Rabies is a virulent and contagious disease especially of the canines, felines, and vulpines, but inoculable in other animals both wild and domestic. The disease has been propagated to wolves, it has been seen in skunks, in raccoons, and in badgers. The disease, while most common in the species enumerated, is communicable by inoculation to all other species of animals, including man and the birds. Birds after inoculation suffer from severe nervous symptoms, but rarely die. The disease is almost invariably fatal in other animals.

Rabies is a disease attended with marked derangement of the nervous system, both central and peripheral. The derangement may manifest itself by increased excitability, by diminished excitability and paralysis, or with perversion of the nerves and special senses.

This disease is referred to four centuries before the Christian era by Democritus. It is also referred to by Aristotle and Plutarch. The first distinct description of the disease was that of Celsus, fifty years before the Christian era. He refers to it under the name of hydrophobia, and recommends the preventive treatment which is the only one that we can adopt, that is excision, cauterization, and suction of the wound with the mouth in order to remove the poison. Again hydrophobia or rabies is referred to by Discordides, Pliny, and Galen. The description of it given by Galen is rather a lengthy one. Since the ninth century, it has been believed that the disease could be relieved by St. Hubert, the patron saint of hunting dogs, and pilgrimages to the shrine of St. Hubert were believed to be beneficial in the case of those bitten by rabid dogs. The disease was known by the Arabs in the twelfth century, and in one of the earliest books on horses, "El Raceri," we find the description of a disease communicable by bites from dogs to horses.

In the seventeenth century the disease was studied by Hamel and Boerhaave, and later by the great surgeon Hunter, who was the leader in the studies of inflammation. In the last century the disease was studied by Majendie, Hertwig, Youatt, and others. During the past few years rabies has been made the subject of special study. The most extensive works that have been written upon this subject are those of Bouley in French and those of Fleming in English. These are the principal authorities to which you can refer. It has also been studied by Leblanc, and in the last few years its mode of development and its prophylaxis has been especially studied by Pasteur.

At the end of the sixteenth century this disease assumed an epizootic form throughout the whole northern part of Italy and the countries bordering on the Adriatic, extending down the Danube into Hungary and Turkey. It reappeared in Hungary in 1714, that is about a century later. It appeared in epizootic form in connection with anthrax in central Europe in 1691 and 1732, so much so that it was supposed by some that there might be some connection between the two diseases. In 1590, 1604, 1719, 1759, 1763, and 1774, it occurred in epizootic form throughout parts of Europe and in England. The medical writers of this time pay considerable attention to the disease. At the end of the eighteenth century it appeared in North America and the West Indies.

In 1803 and 1834 it occurred throughout Switzerland in an epizootic form, attacking a large number of animals. For the last century, the disease has been increasing in western Europe. It is common in Spain, although excessively rare in Portugal. It is comparatively common in England. It is much rarer in Scotland and in Ireland. The disease is known to occur in the Arctic regions. Both Kane and Hayes, the Arctic explorers, give us descriptions of outbreaks of rabies in Southern Greenland among the dogs of the Esquimaux and also among wild animals. So great have these outbreaks been that the Esquimaux have been driven from certain sections, being dependent upon their dogs as a means of travel. During the present century there have been several epizootics among the wild wolves of Russia, and a large number of people have had the disease as a result of being bitten by these animals. In 1838 there was an extensive outbreak in Denmark, and later in 1842 in Vienna.

In 1860 there was a severe outbreak in Lancashire, which is in the neighborhood of Liverpool. So great was the outbreak that one thousand dogs were destroyed by the authorities in order to prevent the spread of the disease. In 1872 there was another extensive outbreak, which was studied by Fleming. The severity of

* A clinical lecture delivered at the Veterinary Department of the University of Pennsylvania.

outbreaks of this disease varies. One or two animals suffering with the disease biting other animals serve to spread the contagion, and as in other contagious diseases, the epizootic spreads until some accident stops its course or the number of animals to be inoculated diminishes.

Rabies is unknown in Australia, in Van Dieman's Land, in the Azores, and in St. Helena. In other islands, as in Iceland, it occurs frequently. In those islands, however, where the disease has never been imported, it is unknown. It was brought to America and to the West Indies only at the close of the last century.

Zundel says of this disease that it is scarcely possible to find two cases which present exactly the same signs and symptoms. It is a disease which is greatly influenced by the race, temperament, sex, age, and the individuality of the animal affected. We find in different races of dogs that the disease will greatly differ. The affectionate, intelligent dogs will do less damage and are more apt to have the disease in a less ferocious form than dogs of a ruder sort.

The older authors divided rabies into some six or seven varieties. At present we divide the disease into three forms: furious, mute or paralytic, and that known as the mixed form. The latter is the most common. In this we have symptoms of the furious form ending in those of the mute or paralytic form.

The etiology we shall to-day leave to one side, as we have not time to take it up, except to say that we distinctly assume that rabies comes from one cause alone, and that is contagion. We apply here the same rule as in all other contagious diseases, where there is doubt, to assume that contagion is the *only* source of origin as the safest thing for the animal and the safest means of checking the spread of the disease by sanitary legal measures. We shall therefore assume that the disease comes only from contagion. The possibility of the spontaneous development of rabies has been thoroughly studied, but no evidence has been found to support this view, and in the immense majority of cases the origin can be distinctly traced to direct contagion.

After the inoculation there is a period of incubation varying from seven days to seven and one-half months. I find that Fleming gives several cases which he claims to be authentic where the period of incubation has been over one year. In one case which I saw myself, the dog was kept in absolute confinement for seven and one-half months after being bitten, where it was impossible for it to receive contagion. He was considered so safe that the owner had been requested to remove him from the hospital, but he developed the first symptoms of the disease on the day that he was to be removed. The ordinary period of incubation is about three or four weeks. Remember, however, that it may be as short as seven days or as long as seven months, and if this long, it may be a year or more.

The symptoms of rabies are generally those of nervous irritation with agitation of a part of the body, as of the head or of the extremities. The animal is restless and a little excitable. The disease may, however, appear with symptoms of nervous depression. The animal may be quieter than usual and become caressing to its owner, so much so that a dog becoming unusually affectionate for a period of several hours should be looked upon with suspicion. At the outset there is a tendency for the dog to lick any cold object, as the floor, a piece of china, or a stone. We find the animal becoming dejected, rather more sober and quiet in its habits, simply as if not well. This is so in any form of disease, but in addition we see a constant restlessness which does not occur at the beginning of other diseases. When a dog is depressed from pneumonia or pleurisy and becomes quiet, he remains so. A dog who has become depressed at the commencement of rabies will become quiet, then throw up his head as if snapping at a fly, and then become quiet again. He gets up without apparent cause and again lies down. After getting curled up, he gets on his feet again. Exceedingly depressed, in the intervals, he shows alternate periods of agitation. These may be so slight as to be scarcely noticeable unless looked for carefully. You have seen these symptoms in the cases which we have recently had, and they were most marked in the last case, that of the setter.

At the outset, we also find a tendency for the animal to scratch and tear things without any reason. That was the history in the case of the spaniel. This dog, after being excessively quiet, suddenly jumped on the bed, pulled off the pillow and tore up the bed clothing, then went into a corner and quietly lay down. We find the animal sniffing at natural articles with which he is familiar, as the carpet, chairs, and other articles of furniture. He sniffs as though taken to a strange place or where there has been another dog. We find that the animal minds his master when spoken to throughout the disease, but he seems to forget and is slow in his movements. He will obey, but in a moment seems to forget what he was told. One of the two cases which we had here two years ago was a black and tan terrier. He would mind his owner as long as he was watched, but the instant the owner would turn to speak to some one, the dog would sneak behind him and try to bite his legs. As soon as the owner would look at him, he would again come to the front. He would have bitten me if I had attempted to handle him, and he would have bitten his owner if he had not been watched.

The animal with rabies has delusions, especially of the special senses. The optic nerve is irritated, so that the animal sees lights and objects that do not exist. The eighth pair is also irritated, so that the animal hears imaginary sounds, and natural sounds are exaggerated. All kinds of sounds and strange objects will increase the irritation in dogs suffering from rabies. Sometimes there seems to be intense pain in the ear, and again in the region of the throat, or in both situations. The animal will be found scratching at its ear as if it had auricular catarrh, but on examination of the ear, nothing abnormal is found. The animal will scratch at its throat as though a foreign body was lodged there. This is one of the most common symptoms at the outset. The animals which you have seen, you will remember were brought here with the history of having a bone in the throat.

There are absolutely no hydrophobic symptoms. Fleming says that there is no dread of water in the rabid dog. There is, from the outset of the disease, no fear of water. The rabid animal is thirsty and would drink if it could, and will attempt to drink. We saw this in two of the cases confined in the iron cage here. Both animals dipped their tongues into the water, but left it, as they were unable to drink on account of the paralysis of the throat. At the commencement of the disease, the dog usually drinks a good deal, but later it is unable to drink. At the outset, the animal takes his ordinary food, but at a later period he leaves ordinary food to take foreign articles by preference. We find it eating straws and sticks. In the last case the dog ate up its muzzle and leather collar. They will eat stones, the manure of a horse, and their own fæces, and will drink their own urine. They will eat dirt from the street, and dig up sods and eat the dirt from the roots.

At the outset there is vomiting, and frequently vomiting of blood. This bloody vomiting is not due simply to the presence of foreign bodies in the stomach, for it has been seen among earlier symptoms in man where no foreign bodies have been swallowed. It has, however, been seen only at the outset of the disease.

In the early period of the disease there is profuse salivation. At a later period the saliva is frequently scanty, so that the mouth is dry. The popular idea is that in later periods of the disease there is profuse salivation, that the mouth and lips will be frothy, and that the saliva will drip from it. You will remember that in the cases brought here the mouth was perfectly dry, the tongue hung from the mouth, and the lips and tongue were covered with dirt and not moist. Remember that the saliva may flow in excess or it may be absent.

There is a change in the voice of the dog, which has been called by Bouley the *voix de cog*. This is a peculiar hoarse sound which resembles the crow of the cock. The bark resembles, to a certain extent, the howl given by a hound lost from the pack. It commences with a low bass sound and ends in a sharp high sound. Another peculiarity of the bark is that it is repeated from five to eight times in rapid succession. The animal is then quiet for a little while, and then the bark is repeated. The howl of the lost dog is never repeated more than two or three times in succession, and the change from the low to the high sound takes place much more slowly than in the dog with rabies.

Among the early signs of rabies is the presence of *lyssa* or the vesicles of Marochetti. These are present in only about fifty per cent. of all cases, and are small vesicles, perhaps little lymphatic tumors seen on the surface of the mucous membrane of the mouth. As they are so frequently absent, they are not of much service in diagnosis.

The sensation of the animal is diminished. The hydrophobic animal does not feel pain as the sound animal does. We see this in twisting the ear in order to hear the voice. In the case of the setter which you saw, the ears could be twisted for some minutes before the animal would show signs of pain. Ordinarily the animal would have howled at the first touch. I have seen a hydrophobic animal take hold of a red hot bar of iron and hold it as he would a stick, without evincing any pain. In this case the animal was in a furious state.

There is frequently in this disease a pruritus, that is a hyperanæsthesia in the neighborhood of the pharynx that causes the scratching at the throat. The animal will scratch at the old scar until it breaks out in an open sore. In the horse this is almost invariably present. It is not so common in the dog. In the hog again it is quite frequent. We also find irritation of the genital organs, attended with priapism and emission of seminal fluid. This is found in all animals, but it is more common in the case of cattle than in other animals.

In the second stage of rabies we may have the animal developing a greater excitability and becoming furious. The eyes will have a staring look as if fixed intently upon some object, but upon no definite one. This was well seen in the setter. That animal traveled for hours around his cage until in fact all his bedding disappeared. If you came into the kennel, or spoke to him attracting his notice, he would look at you intently, and then his eyes would wander off with the same look, but directed toward no definite object. This is one of the very characteristic symptoms. The pupils are invariably dilated. The animal seems forgetful. He will attack another dog, and after biting him once or twice, bears no malice against him, but is just as willing to turn around and bite another dog or some other animal. There is apparently no memory during the excitable stage. There will, however, be intervals of intelligence. After wandering for a period, he will remain quiet for a time, but will start up if disturbed, especially by any sudden sight or sound. In the furious stage the dog prefers to bite another dog rather than any other animal. A dog with a man acts as a safeguard against a rabid dog. The mad dog will bite the dog in preference to biting the man.

In this excitable stage the dog travels until exhausted or until commencing paralysis forces it to again become quiet, when, if it has the strength, it will frequently return to its home.

The second stage may be one of paralysis instead of a furious condition. After premonitory symptoms, which are excessively difficult, the animal quietly curls in a corner, is affected with paralysis, and dies without ever having been furious, or, as in one case which we had, the animal would have been furious if it had had the strength. It would snap at things, but on account of the paralysis of the jaw, it had no strength to hold on.

In the mute or paralytic form we have the throat trouble most marked, and this is followed at once by paralysis of the lower jaw and of the tongue. Most of the cases which we have recently seen have been of this form. In this form, in the absence of saliva, the tongue becomes dry and covered with dirt. The animals are restless, turn round and scrape up their bedding, and present the peculiar staring fixed look which is seen in the furious form. Yet the animal will want to be caressed by the owner. There may, however, be salivation at the outset. The appetite is preserved, but the animal is unable to swallow. It will go to its food and pan of water and attempt to eat and drink, but is unable to do either. The pharynx is choked with all sorts of foreign matter. Inside the pillars of the throat and between the back teeth and the cheeks will be found foreign matter which the animal has attempted to swallow. After a time the paralysis becomes complete and the jaw drops open, remaining in that position.

The sight of other dogs does not excite a dog with mute hydrophobia as it does a dog with the furious form of the disease. In the former variety there is little or no tendency to bite. If there is a tendency to bite, the dog is unable to exert any amount of force on account of the paralysis of the muscles, and hence its bite is innocuous. In the mute form the paralysis of the throat extends to other portions of the body until the animal is totally paralyzed and dies in this condition.

In other animals the disease occurs with rather more distinctive symptoms and without the great variability that is seen in the dog. In the horse, the disease can almost be traced to inoculation. One of the first symptoms in the horse will be found to be irritability at the point of inoculation. If, for instance, the bite has been on the lip, we will find that the first sign of the development will be that the horse rubs the perfectly healed scar against the manger, and in the course of half an hour there will be a large sore where the bite occurred. The horse refuses food, becomes nervous, turns its head rapidly, watches the entrance of the stable attendant, and watches what the other animals in the stable are doing. From this the horse goes into a furious stage, biting at anything within reach, kicking at any other animal or man that approaches, and does this with perfect reason. When a rabid horse kicks, it looks where it is kicking. When he attempts to bite, he knows what he is trying to do. This enables us to make a perfectly clear differential diagnosis between rabies in the horse and the fury which attends meningitis. In the latter affection, the horse is just as furious, but it makes little difference to it what it kicks.

A man entering the stall of a horse suffering with meningitis is perfectly safe if he keeps carefully to the side where he can avoid the kick or the bite. Two men can readily manage such a horse by guiding it from each side. The animal kicks and bites without knowing what he is doing. In the rabid horse there is also venereal excitement, priapism, and in the stallion emission of seminal fluid. The horse invariably dies in a short time from traumatism, as from fracture of the upper jaw, with hemorrhage, or falling and breaking a leg or the pelvis back, or producing hemorrhage in some other way. Throughout, the horse is in an excitable state, although this may end in paralysis.

In cattle we have the excitable condition. The animal commences to bellow, to paw and tear up the ground with its horns, tear at the fences, and in the stable at anything within reach of its horns. The eyes have the same staring expression that has been referred to in the case of the dog. If the animal does not die from traumatism, paralysis comes on in five or six days, during which there have been almost continuous successive attacks of fury with certain intermissions of tranquillity.

In sheep there are the same general symptoms. The animal becomes excited, butting with its head and with its horns if it has any, but neither in sheep nor in cattle do we have any tendency for the animal to bite. The horse bites and strikes with its fore feet, which in that animal serve as weapons of offense and defense. The other animals use only their ordinary arms, their horns and feet. Cases have been seen in which sheep would eat animal food and drink blood during the course of the disease, animal food being as unnatural for the sheep as foreign bodies for the dog.

In pigs there is intense pruritus at the point of inoculation. The animal shows general malaise, and a period of discomfort, is restless, and looks around. It finally becomes excessively savage toward any other form of animal. A sow with small pigs, in the intervals between the attacks of fury, will be much more attentive to her young, and caresses and suckle them more than when in a state of health. In the furious stage she will injure her young, just as she would any other animal.

The lesions of hydrophobia are nearly all secondary. The *lyssa* or vesicles of Marochetti are not always present, as has already been stated. Of course, where the dog has obtained foreign matter, it will be found in the stomach. In considering this subject I shall confine myself to the lesions found in the dog. The presence of foreign matter is not absolutely diagnostic, for we sometimes find the same condition in gastritis and enteritis. There is usually, and in the paralytic form always, intense congestion of the throat, palate, pharynx, and larynx. There is general congestion and usually œdema of the muscles of the pharynx and larynx in the paralytic condition. We find also congestion of the internal organs, especially of the membranes. We find petechiæ in the walls of the stomach, in the intestine, in the mesentery. We find petechiæ and ecchymotic spots in the lungs. We find the brain in a congested condition, especially the isthmus that is from the corpus striatum back to the medulla. There is also intense congestion in the back part of the medulla, that is commencing with the roots of the fifth pair of nerves and extending to the hypoglossal. The nerves most markedly affected are the fifth, seventh, and eighth pairs and hypoglossal nerves. The sixth the least. There is little irritation on the part of the pneumogastric either as indicated by the symptoms or by the post mortem results. The glosso-pharyngeal nerve is also involved.

Under the microscope there is found to be proliferation of the white cells, and of the amœboid cells in the white matter, but more in the gray matter in the posterior part of the medulla. These are the only lesions that we find that are of any importance. The lesions of hydrophobia were first thoroughly studied by Eckel and Bruckmuller, whose investigations were made in Vienna.

The poison or contagium of hydrophobia or rabies, which we assume to be the only cause of the disease, is certainly propagated throughout the nervous system. Inoculation of the blood rarely gives any definite result. The virus is eliminated by the salivary glands, so that the saliva is capable of producing the disease in other animals. Again the poison is found in the nervous system, in the medulla, and in the anterior part of the spinal cord. As you saw recently, the inoculation of a portion of the spinal cord from a rabid dog into the subcutaneous tissue of the neck of a sound dog produced the disease in nineteen days. That there exists in the medulla a poison capable of producing the disease, a poison which will be attenuated by exposure to the air, was shown by Pasteur. The poison in the saliva, which is at first virulent, disappears to a great extent in the course of twelve hours after death, that is by the time that the body has become cold. The poison remains in the nervous system so long as decomposition has not taken place, and the part is surrounded by carbonic acid and is protected from the air. It will remain active at least six weeks in an un-

opened dog buried in a cold grave. On exposure of the spinal cord to the air, the poison gradually becomes attenuated and finally disappears.

Pasteur took a piece of medulla from a rabid dog, cut it into sections, and placed each piece in separate jars, numbered from one to fifteen. In each jar was placed a small piece of caustic potash to absorb any moisture which would favor decomposition. It is found that at the end of fifteen days' exposure, the nervous mass has lost its virulence. At the end of fourteen days it still exists, but in a very attenuated form. So it gradually increases in virulence until the cord which has been kept only two or three days is as virulent as that directly from the animal. Pasteur found that when the inoculation was made directly from the animal, the period of incubation was not the same, due probably to varying intensity of the poison in different cases. It was found that some died seven days after inoculation, some ten days, some fifteen, and some lived as long as three weeks. By successive inoculations from rabbit to rabbit it was found that the period of incubation was shortened, and when a series of twenty-two inoculations had been made, it was found that the period of incubation was fixed, and did not vary six hours from seven days, the extremes being six days and eighteen hours and seven days and six hours. This fixed virus was then kept from one to fifteen days. It was found that from the first to the eighth day it would invariably produce the disease in a varying period of time, sometimes a week, sometimes two weeks, and at times even three weeks.

It was found that the weaker virus, that kept from the eighth to the fifteenth day, would not produce the disease. It was found that if the weak virus, from the thirteenth to the fifteenth day, were inoculated, and this followed by the inoculation of the stronger virus, the disease would be longer in developing. It was also found that by following the inoculation of the material kept thirteen to fifteen days by that kept ten to twelve days, the disease would not appear. This was followed by the inoculation of material kept from three to eight days, and then by that kept one day, and this by virus direct from the animal, and yet rabies would not be produced, while inoculations of the same material into animals not previously inoculated would produce the disease. We have therefore ample proof of the presence of a virus capable of attenuation and self-protection, just as we have in the attenuation of the bacillus anthracis by lengthy exposure and heat. It was also found that these inoculations could be made with considerable rapidity, and could be made after the animal had been inoculated subcutaneously with the pure virus, and that a series of these inoculations would serve as a protection. These experiments were carried to such a stage that Pasteur had in his laboratory fifty dogs that were absolutely refractory to inoculations which would produce the disease in dogs not previously inoculated with weaker viruses.

At this stage of his investigations, with the authority and the advice of one of the most prominent physicians of Paris, Pasteur undertook these inoculations on the human being, which have been extended to a large number, but with rather doubtful results. The investigations of Pasteur have certainly aided us greatly in the recognition of the nature of the disease, but the success of his prophylactic treatment is certainly still a question.

A large number of persons who have submitted to these inoculations have died of hydrophobia, and with our present knowledge of the mode of propagation of the poison, it is certainly a question whether or not the disease has not been communicated by the inoculations which have been made for purposes of protection.

JOHN DALTON.

AT a recent meeting of the Glasgow Chemists' and Druggists' Association, Assistants' Section, the lecture was delivered by Prof. Humboldt Sexton, the subject being "John Dalton and the Atomic Theory." The early life and education of Dalton having been referred to, Prof. Sexton said that the first appointment which the celebrated philosopher received was in 1793, as lecturer on mathematics and natural philosophy in a Protestant Dissenters' college at Manchester. There his intellectual life may be said to have begun, and soon after he gave evidence of it in a paper communicated to the local literary and philosophical society, which dealt with certain curious defects in his own vision, in consequence of which his perception of colors was different from that of most people. Scarlet always appeared to him to be gray, and he had similar illusions about other colors. This aberration he attributed to the presence of some coloring matter in one of the humors of his eyes—a supposition that was disproved when, by examination after death, both of these organs were found to be quite normal.

The optical infirmity first described by Dalton, and long called Daltonism, is now familiar to everybody as color blindness, and is due to some physiological cause. When Dalton made his first acquaintance with chemistry, it was slowly rising from the smouldering ashes of alchemy, but had not yet assumed any organized form. The difference between elements and compounds was recognized, the more striking phenomena of chemical combination in respect of changes of color and physical properties were well known; but the fact that the same substances have always the same chemical composition was not generally admitted. He had scarcely crossed the frontier line of his investigations when he discovered, working on the oxides of cobalt and nickel, the law of multiple proportions, and from this the moulding of the atomic theory was a mere matter of time.

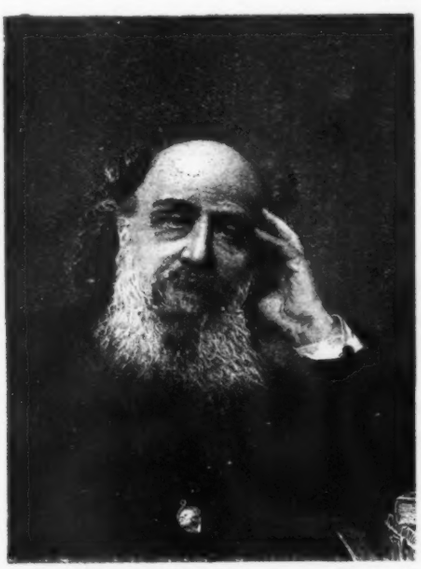
Of this and all the other principal investigations of Dalton, Prof. Sexton gave an eloquent and interesting account. Speaking of the man personally, he said that to the last he wore the quaint Quaker costume, and persisted in all the old-world customs of that sect. In the business of life he was punctilious to a fault. Day after day the same rigorous routine was fulfilled down to the minutest detail, and the good people of Manchester who lived in the line of his accustomed routes might safely have set their clocks by the times of his passing—so punctually and regularly did his movements recur. A man of powerful mind and firm purpose, as his portraits show, he was so strongly self-reliant as always to chafe at the suggestion of external aid or advice, and being indifferent to literary pursuits, and isolated from mixed society by reason of his religious training and laborious life, he was essentially narrow minded, preferring his own modes of thought and action even when they had been proved to be wrong. Alike in person and deportment he was rough and ungainly.

Among the relics of him in Sir H. E. Roscoe's possession are his hat and shoes, and on one occasion, at a gathering at which many eminent chemists were present, some of us tried on the hat, but it went right down over everybody's ears. As for the shoes, Sir Henry Roscoe jocularly remarked that many a chemist would like to step into them; but literally, as well as figuratively, few could fill them. Dalton would have had little sympathy with the delicate processes and adjustments of modern chemistry. In his opinion absolute accuracy in experiment was unnecessary. Anything could be made to serve as apparatus—old ink bottles, medicine phials, etc., were pressed into the service, and, strangely enough, with such rudimentary materials he worked out the grandest results. Even when he had become a famous man he "worked for his living," giving lessons at the rate of 2s. 6d. per hour. In the course of the lecture there were thrown on the screen photographs of Dalton's bust from the painting and statue, and facsimiles of an autograph letter, and the tables of atomic weights in his treatise on the "New System of Chemistry."

[NATURE.]

JAMES JOSEPH SYLVESTER.

JAMES JOSEPH SYLVESTER, born in London, on September 3, 1814, is the sixth and youngest son of the late Abraham Joseph Sylvester, formerly of Liverpool.* He was educated at two private schools in London, and at the Royal Institution, Liverpool, whence he proceeded in due course of time to St. John's College, Cambridge. In these early days he manifested considerable aptitude for mathematics, and so it was not matter for surprise that he came out in the Tripos examination of 1837 as



JAMES JOSEPH SYLVESTER.

Second Wrangler; being incapacitated, by the fact of his Jewish origin, from taking his degree, he was not able to compete for either of the Smith's prizes. In more enlightened times (1872) he had the degrees of B.A. and M.A., by accumulation, conferred upon him, and received therewith the honor of a Latin speech from the public orator. He himself says: "I am perhaps the only man in England who am a full (voting) Master of Arts for the three universities of Dublin, Cambridge, and Oxford, having received that degree from these universities in the order above given: from Dublin, by *ad eundem;* from Cambridge, *ob merita;* from Oxford, by decree." He is now D.C.L. of Oxford, LL.D. of Dublin and Edinburgh, and Hon. Fellow of St. John's College, Cambridge. It is still open for him to receive yet higher recognition from his own *alma mater*.

Prof. Sylvester became a student of the Inner Temple, July 29, 1846, and was called to the bar on November 22, 1850.† He has been professor of natural philosophy at University College, London; of mathematics at the University of Virginia, U. S. A.;‡ then ten years later professor at the Royal Military Academy, Woolwich; and again, after a five years' interval, professor of mathematics at the Johns Hopkins University, Baltimore, U. S. A., from its foundation in 1877. Finally, in December, 1883, he was elected Savilian professor of geometry at Oxford, in succession to Prof. Henry Smith.§ His first printed paper was on Fresnel's optical theory (in the *Phil. Mag.*, 1837).

We can here only briefly allude to a communication which was accompanied by many important results: we refer to the Friday evening address (January 23, 1874) to the Royal Institution, "On Recent Discoveries in Mechanical Conversion of Motion." He says: "It would be difficult to quote any other discovery which opens out such vast and varied horizons as this of Peaucellier's—in one direction descending to the wants of the workshop, the simplification of the steam engine, the revolutionizing of the mill-wright's trade, the amelioration of garden pumps and other domestic conveniences (the sun of science glorifies all it shines upon), and in the other soaring to the sublimest heights of the most advanced doctrines of modern analysis, lending aid to and throwing light from a totally unexpected quarter on the researches of such men as Abel, Riemann, Clebsch, Grassmann, and Cayley. Its head towers above the clouds, while its feet plunge into the bowels of the earth."

The only works that Prof. Sylvester has published, we believe, are: (1) "A Probationary Lecture on Geometry, delivered before the Gresham Committee and the Members of the Common Council of the City of London, December 4, 1854," a slight thing which had to be written and delivered at few hours' notice; (2) "Laws of Verse," 1870; (3) several short poems, sonnets, and translations, which have appeared in our columns and elsewhere.

Our notice would be incomplete without some record of the honors that have been conferred upon Dr. Sylvester. He was elected a Fellow of the Royal Society on April 25, 1839; has received a Royal medal (1860) and the Copley medal (1880), this latter rarely awarded, we believe, to a pure mathematician.

On this last occasion, Mr. Spottiswoode accompanied the presentation with the words: "His extensive and profound researches in pure mathematics, especially his contributions to the theory of invariants and covariants, to the theory of numbers and to modern geometry, may be regarded as fully establishing Mr. Sylvester's claim to the award." He is a Fellow of New College, Oxford; Foreign Associate of the United States National Academy of Sciences; Foreign Member of the Royal Academy of Sciences, Gottingen, of the Royal Academy of Sciences of Naples, and of the Academy of Sciences of Boston; Corresponding Member of the Institute of France, of the Imperial Academy of Science of St. Petersburg, of the Royal Academy of Science of Berlin, of the Lyncel of Rome, of the Istituto Lombardo, and of the Societe Philomathique. He has been long connected with the editorial staff of the *Quarterly Journal of Mathematics* (under one or another of its titles), and was the first editor of and is a considerable contributor to the *American Journal of Mathematics;* and he was at one time examiner in mathematics and natural philosophy in the University of London. He was not an original member of the London Mathematical Society (founded January 16, 1865), but was elected a member on June 19, 1865, vice-president on January 15, 1866, and succeeded Prof. De Morgan as the second president on November 8, 1866. The society showed its recognition of his great services to them and to mathematical science generally by awarding him its De Morgan gold medal in November, 1887. Wherever Dr. Sylvester goes, there is sure to be mathematical activity; and the latest proof of this is the formation, during the last term at Oxford, of a mathematical society, which promises, we hear without surprise, to do much for the advancement of mathematical science there.

The writings of Sylvester date from the year 1837; the number of them in the Royal Society Index up to the year 1863 is 112, in the next ten years 38, and in the forthcoming volume 81, making 231 for the years 1837 to 1883; the number of more recent papers is also considerable. They relate chiefly to finite analysis, and cover by their subjects a large part of it; algebra, determinants, elimination, the theory of equations, partitions, tactic, the theory of forms, matrices, reciprocants, the Hamiltonian numbers, etc.; analytical and pure geometry occupy a less prominent position; and mechanics, optics, and astronomy are not absent. A leading feature is the power which is shown of originating a theory or of developing it from a small beginning; there is a breadth of treatment and determination to make the most of a subject, an appreciation of its capabilities, and real enjoyment of it. There is not unfrequently an adornment or enthusiasm of language which one admires, or is amused with; we have a motto from Milton or Shakespeare; a memoir is a trilogy divided into three parts, each of which has its action complete within itself, but the same general cycle of ideas pervades all three, and weaves them into a sort of complex unity; the apology for an unsymmetrical solution is—symmetry, like the grace of an Eastern robe, has not unfrequently to be purchased at the expense of some sacrifice of freedom and rapidity of action; and, he remarks, may not music be described as the mathematic of sense, mathematic as the music of the reason? the soul of each the same, etc. It is to be mentioned that there is always a generous and cordial recognition of the merit of others, his fellow-workers in the science.

It would be in the case of any first-rate mathematician—and certainly as much so in this as in any other case—extremely interesting to go carefully through the whole of a long list of memoirs, tracing out as well their connection with each other and the several leading ideas on which they depend, as also their influence on the development of the theories to which they relate; but for doing this properly, or at all, space and time, and a great amount of labor, are required. Short of doing so, one can only notice particular theorems—and there are, in the case of Sylvester, many of these, "beautiful exceedingly," which, for their own sakes, one is tempted to refer to—or one can give titles, which, to those familiar with the memoirs themselves, will recall the rich stores of investigation and theory contained therein.

A considerable number of papers, including some of the earliest ones, relate to the question of the reality of the roots of a numerical equation; in the several connections thereof with Sturm's theorem, Newton's rule for the number of imaginary roots, and the theory of invariants. Sylvester obtained for the Sturmian functions, divested of square factors, or say for the reduced Sturmian functions, singularly elegant expressions in terms of the roots; these were $f_3(x) = \Sigma(a-b)^2(x-c)(x-d)\ldots$, $f_4(x) = \Sigma(a-b)^2(a-c)^2(b-c)^2(x-d)\ldots$, etc.; but not only this; applying the Sturmian process of the greatest common measure (not to $f(x), f'(x)$, but instead) to two independent functions $f(x), \varphi(x)$, he obtained for the several resulting functions expressions involving products of differences between the roots of the one and the other equation, $f(x) = 0$, $\varphi(x)$

* Foster's "Hand-book of Men at the Bar."

† Foster, l. c.

‡ The late Prof. Key, of University College and School, was the first occupant of the chair, founded by Mr. Jefferson, once President of the United States, in 1824.

§ He commences his Oxford lecture (*Nature*, vol. xxxiii., p. 222), of date December 12, 1885, with the words: "It is now two years and seven days since a message by the Atlantic cable containing the single word 'elected' reached me in Baltimore, informing me that I had been appointed Savilian Professor of Geometry in Oxford, so that for three weeks I was in the unique position of filling the post and drawing the pay of Professor of Mathematics in each of two universities."

$= 0$; the question then arose, What is the meaning of these functions? The answer is given by his theory of *intercalations:* they are signaletic functions, indicating in what manner (when the real roots of the two equations are arranged in order of magnitude) the roots of the one equation are intercalated among those of the other. The investigations in regard to Newton's rule (not previously demonstrated) are very important and valuable; the principle of Sturm's demonstration is applied to this wholly different question, viz., x is made to vary continuously, and the consequent gain or loss of changes of sign is inquired into. The third question is that of the determination of the character of the roots of a quintic equation by means of invariants. In connection with it we have the noteworthy idea of *facultative* points, viz., treating as the co-ordinates of a point in n-dimensional space those functions of the coefficients which serve as criteria for the reality of the roots, a point is facultative or non-facultative according as there is, or is not, corresponding thereto any equation with real coefficients; the determination of the characters of the roots depends (and, it would seem, depends only) on the bounding surface or surfaces of the facultative regions, and on a surface depending on the discriminant. Relating to these theories there are two elaborate memoirs, "On the Syzygetic Relations, etc.," and "Algebraical Researches, etc.," in the Philosophical Transactions for the years 1853 and 1864 respectively; but as regards Newton's rule later papers must also be consulted.

In the years 1851–54, we have various papers on homogeneous functions, the calculus of forms, etc. (*Cambridge and Dublin Math. Journal*, vols. vi. to ix.), and the separate work "On Canonical Forms" (London, 1851). These contain crowds of ideas, embodied in the new words: cogredient, contragredient, concomitant, covariant, contravariant, invariant, emanant, combinant, commutant, canonical form, plexus, etc., ranging over and vastly extending the then so-called theories of linear transformations and hyperdeterminants. In particular, we have the introduction into the theory of the very important idea of continuous or infinitesimal variation; say that a function, which (whatever are the values of the parameters on which it depends) is invariant for an infinitesimal change of the parameters, is absolutely invariant.

There is, in 1844, in the *Philosophical Magazine*, a valuable paper, "Elementary Researches in the Analysis of Combinatorial Aggregation," and the titles of two other papers, 1865 and 1866, may be mentioned: "Astronomical Prolusions; commencing with the instantaneous proof of Lambert's and Euler's theorems, and modulating through the construction of the orbit of a heavenly body from two heliocentric distances, the subtended chord, and the periodic time, and the focal theory of Cartesian ovals, into a discussion of motion in a circle and its relation to planetary motion;" and the sequel thereto, "Note on the periodic changes of orbit under certain circumstances of a particle acted upon by a central force, and on vectorial co-ordinates, etc., together with a new theory of the analogues of the Cartesian ovals in space."

Many of the later papers are published in the *American Mathematical Journal*, founded in 1878, under the auspices of the Johns Hopkins University, and for the first six volumes of which Sylvester was editor-in-chief. We have, in vol. i., a somewhat speculative paper entitled "An application of the new atomic theory to the graphical representation of the invariants and covariants of binary quantics," followed by appendices and notes relating to various special points of the theory, and in the same and subsequent volumes various memoirs on binary and ternary quantics, including papers (by himself, with the aid of Franklin) containing tables of the numerical generating functions for binary quantics of the first ten orders, and for simultaneous binary quantics of the first four orders, etc. The memoir (vols. ii. and iii.) on "Ternary cubic form equations" is connected with some early papers relating to the theory of numbers. We have in it the theory of residuation on a cubic curve, and the beautiful chain rule of rational derivation, viz., from an arbitrary point 1 on the curve it is possible to derive the singly infinite series of points $(1, 2, 4, 5, \ldots 3p \pm 1)$ such that the chord through any two points, m, n, again meets the curve in a point $m + n$, $m - n$ (whichever number is not divisible by 3) of the series; moreover, the co-ordinates of any point m are rational and integral functions of the degree m^2 of those of the point 1.

There is in vol. v. the memoir, "A Constructive Theory of Partitions arranged in three acts, an Interact in two parts, and an Exodion," and in vol. vi. we have "Lectures on the Principles of Universal Algebra" (referring to a course of lectures on multinomial quantity, in the year 1881). The memoir is incomplete, but the general theories of nullity and vacuity, and of the corpus formed by two independent matrices of the same order, are sketched out; and there are in the *Comptes Rendus* of the French Academy later papers containing developments of various points of the theory—the conception of "niveliators" may be referred to.

The last mentioned paper in the *American Mathematical Journal* was published subsequently to Sylvester's return to England on his appointment as Savilian Professor of Mathematics at Oxford. In December, 1886, he gave there a public lecture containing an outline of his new theory of reciprocants (reported in *Nature*, January 7, 1887), and the lectures since delivered are published under the title, "Lectures on the Theory of Reciprocants" (reported by J. Hammond), same journal, vols. viii. to x.; thirty-three lectures actually delivered, entire or in abstract, in the course of three terms, to a class in the university, with a concluding so-called lecture 34, which is due to Hammond. The subject, as is well known, is that of the functions of a dependent variable, y, and its differential co-efficients, y', y'', . . . , in regard to x (or, rather, the functions of y', y'', . . .), which remain unaltered by the interchange of the variables x and y: this is a less stringent condition than that imposed by Halphen ("Thèse," 1878) on his differential invariants, and the theory is accordingly a more extensive one. A passage may be quoted: "One is surprised to reflect on the change which is come over algebra in the last quarter of a century. It is now possible to enlarge to an almost unlimited extent on any branch of it. These thirty lectures, embracing only a fragment of the theory of reciprocants, might be compared to an unfinished epic in thirty cantos. Does it not seem as if algebra had attained to the dignity of a fine art, in which the workman has a free hand to develop his conceptions, as in a musical theme or a subject for painting? Formerly, it consisted in detached theorems, but nowadays it has reached a point in which every properly developed algebraical composition, like a skillful landscape, is expected to suggest the notion of an infinite distance lying beyond the limits of the canvas." And, indeed, the theory has already spread itself out far and wide, not only in these lectures by its founder, but in various papers by auditors of them and others—Elliott, Hammond, Leudesdorf, Rogers, MacMahon, Berry, Forsyth.

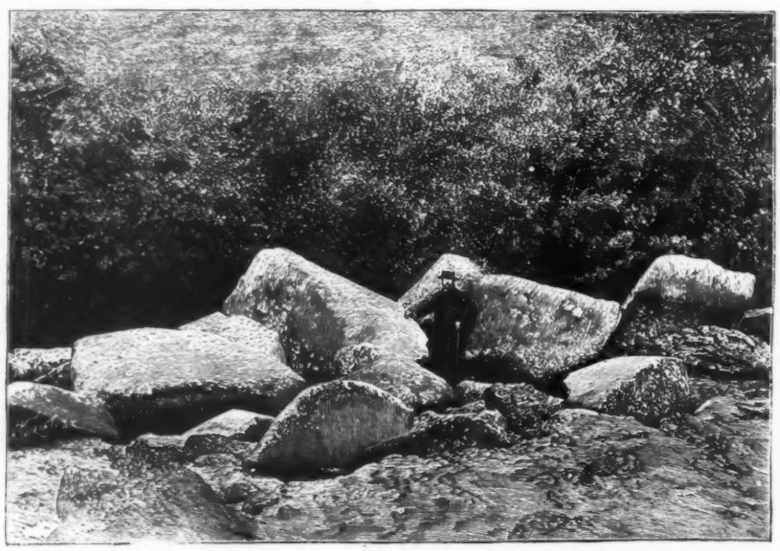
Sylvester's latest important investigations relate to the Hamiltonian numbers; there is a memoir, *Crelle*, t. c. (1887), and, by Sylvester and Hammond jointly, two memoirs in the Philosophical Transactions. The subject is that of the series of numbers 2, 3, 5, 11, 47, 923, calculated thus far by Sir W. R. Hamilton in his well-known report to the British Association, on Jerrard's method. A formula for the independent calculation of any term of the series was obtained by Sylvester, but the remarkable law by means of a generating function was discovered by Hammond, viz. E_0, E_1, E_2, . . . being the series 3, 4, 6, . . . of the foregoing numbers, each increased by unity; then these are calculated by the formula $(1-t)E_0+t(1-t)E_1+t^2(1-t)E_2+\ldots = 1-2t$, equating the powers of t on the two sides respectively; observe the paradox, $t = \frac{1}{2}$, then the formula gives 0 = sum of a series of positive powers of $\frac{1}{2}$.

Enough has been said to call to mind some of Sylvester's achievements in mathematical science. Nothing further has been attempted in the foregoing very imperfect sketch.

A. CAYLEY.

THE SOUNDING ROCKS OF GUILDO.

NOT far from Dinan, on the banks of the Arguenon, one of those small torrential rivers which, in emptying into the sea, carve the coast of Brittany into capricious festoons, there is shown to the tourist a heap of grayish rocks known in the country under the name of the "sounding stones of Guildo."



THE SOUNDING ROCKS OF GUILDO.

In the crystalline texture of these rocks and their slaty color we at once recognize that variety of stone known in mineralogy by the name of amphibole (complex silicate of iron, manganese, and lime). These stones, which, aside from their musical properties, possess no novelty, are situated in the midst of wonderful scenery. They occupy a small cove, that at rising tide is entirely covered, and which is overlooked by a high bank, upon which stands the little village of Guildo, formerly the center of a celebrated pilgrimage. Opposite them, on the other side of the Arguenon, which at this place is no less than 980 feet wide, stand, sad and desolate, the ruins of the Castle of Guildo, still preserving in their massive structure something of a menacing aspect. Upon gazing at these proud witnesses of a so distant past, one involuntarily thinks of that stirring figure of Gilles de Bretagne, so often evoked in the legends of the country. It was within these walls, now mined on every side by a luxuriant vegetation, that passed the first scenes of that fratricidal tragedy which was to have its sorrowful epilogue in the Castle of Hardouinaie, near Rennes. Upstream widens out the pretty valley of the Arguenon, so dear to the Breton poets, and which is crossed by a new iron bridge. Downstream the river gradually widens out its estuary, and its right bank terminates in the curious peninsula of Saint Jacut, upon which rise, picturesquely, one above the other, the white houses of the market town, facing east and west. The left bank ascends more to the north and terminates in the point of St. Cast, a name that sounds well to the ears of the Breton patriots.

The stones of Guildo are not erratic blocks derived from the upper part of the valley. It is clearly seen that they have been detached from the bank itself, the strata of which are of rock of the same formation. They are huge bowlders rolled and polished by the sea. When, at the rising of the tide, the *Norouet* wind blows in a tempest, the waves break over the points of Saint Jacut and ascend the river bed with irresistible force. Now, the sounding rocks stand at the very point where, in consequence of a slight bend in the course of the Arguenon, the fresh descending water comes into contact with the salt ascending stream. Under the repeated stresses of these two opposite currents, the huge rocks clash against each other, wear away, and gradually become polished.

The sounding stones are three in number. They are long prismatic blocks, lying side by side, at right angles with the shore, and, because of their form, the inhabitants sometimes call them "the horses in the stable." The central stone more particularly exhibits the phenomenon. It is about twenty feet in length and twenty-three in circumference, thus giving it an approximate weight of 165,000 pounds. On the river side, it ends in a sort of truncated spur. It is at this part that it is necessary to strike it with an iron instrument, or, better, with a stone of the same nature. Near this spur there are observed three or four joints that are well marked by the wear produced by the repeated blows of visitors. These are the points at which the maximum of sonorousness is obtained.

Under a blow, the stone emits a very clear, silvery sound, similar to that which would be obtained by striking a large bell with a mallet of soft wood. The sound, as far as a hurried examination allowed us to judge, corresponds to *mi*$_3$. The more one approaches the other end, in continuing the blows, the deader the sound becomes. Near the top, the tonality seems to increase a little. Finally, at certain points, which must be nodes of vibration, merely a dull sound is obtained. If, while striking, one presses his ear against the other extremity of the rock, the sound heard is extraordinarily intense, and, in measure as it dies out, the various harmonies are distinctly perceived. The two other stones emit nothing more than a muffled sound. It is asserted that this is due to the fact that they have been disturbed by the action of the sea. In fact, it is to be noted that the musical stone rests through a few points only upon the pebbles that support it, while the two others are now partially sunk in the subjacent earth.

We examined all the surrounding stones and found several that gave very varied sounds, without there seeming to be any relation between their size and the height of the pitch. At the end of the cove, we more particularly remarked a horizontal stratum partially buried in the shore and divided into fragments, forming as it were something like the gigantic keys of a prehistoric piano. Three of these stones gave clearly the perfect major chord. While watching our researches with curiosity, a boy of the locality exclaimed now and then, previous to our experiments: "Will sound!" "Won't sound!" and accustomed to making the singular stones speak, he soon showed us how, at the first glance, it was possible to recognize the musical stones. The rocks, in fact, exhibit two very different aspects.

Those of a silvery gray, with a very fine texture, all render, even when broken, a very pure sound. Those of a darker color and blotched with brown, through an excess of iron, are as if exfoliated, and emit no sound. The bank of diorite must have been traversed by a ferruginous vein, for, at more than one point, we found large rubble stones composed of the two kinds of rock.

Is there need of saying that the sounding rocks have more than once furnished their contingent to the already rich legendary of the Breton country? We were struck by one of these legends, for we found therein a *scenario* that has been exploited, with variants, more than once in the Armorican country. It is the story of a tailor (hump-backed, of course), who one fine evening obligingly assisted in completing the round of the fairies of Guildo, who were disconsolate over being in unequal numbers. As a reward, the fairies taught him to "sound the stone" in making a wish. At the call of the mysterious bell, there came from the depths of the earth gnomes and elves who satisfied the fortunate tailor's wishes and began, in the first place, by ridding him of his hump. Then comes the usual counterpart: The artful and scoffing miller of the valley of the Arguenon wished to imitate the tailor and succeeded only in making the fairies hostile. They avenged themselves on him by ridding themselves, at his expense, of the tailor's hump.

The sounding rocks of Guildo are scarcely known except in the country, and most authors who have written about Brittany do not even mention them.—*La Nature.*

THE ARTESIAN WELL AT CITY PARK, DAVENPORT, IOWA.

By A. S. TIFFANY.

THIS well is situated 160 feet above low water in the Mississippi, and 688 feet above the sea.

		Thickness—feet.	
Drift 100 feet.	1.—Loess 40 feet; bowlder clay 60 feet	100	
Coal measures 30 feet.	2.—Dark clay shale.....	30	130
	3.—Hard drab limestone..	220	350
	4.—Cream colored " ..	30	380
Corniferous	5.—Hard, porous limestone, buff.....	20	400
390 feet.	6.—Drab limestone, hard.	90	490
	7.—Very dark blue calcareous shale.....	30	520
Lower Helderberg, 80 feet.	8.—Soft, buff limestone, Le Claire	80	600
Niagara	9.—Hard, rough, drab limestone.....	50	650
175 feet.	10.—Drab limestone.	75	725
	11.—Hard shaly limestone.	50	775
Cincinnati and Trenton, 300 feet.	12.—Dark gray limestone..	125	900
	13.—Dark drab limestone..	50	950
	14.—Soft white limestone..	75	1,025
	15.—Soft white limestone..	50	1,075
	16.—Blue clay shale, with silica.....	10	1,085
Calciferous	17.—St. Peter sandstone, white....	90	1,175
group	18.—Arenaceous shale, drab, blue, and red.	15	1,190
Magnesian	19.—Magnesian limestone, with ten per cent.		
limestone of	silica; cement rock..	210	1,400
	20.—No record.....	25	
the Mo. reports	21.—Sandstone (by city engineer).....	10	1,435
512 feet.	22.—Limestone (borings washed away).	100	
	23.—Limestone.....	262	
		1,797	

NOTE.—No. 4 contained fossils, viz.: Paracyclas tenuis Hall, Platystoma turbinatus Hall, Cyrtina hamiltonensis Hall, Cladopora and Pleurotomaria, undetermined; No. 7 contained Pantamerella arata Con. or P. papilionensis Hall.

It appears that 80 feet or more were eroded from the Corniferous before the coal shales were deposited. The upper 80 feet of the Corniferous at this place have well marked lithological features, which could be readily recognized in the borings. Nos. 4 to 7 do not outcrop in this county, having been depressed by the great fault, nine miles above, at Valley City. The St. Peter sandstone furnished abundance of water, which stood within 50 feet of the surface. The porous strata at 400 feet let the water escape. The well was piped 1,100 feet, when the water stood 22 feet from the surface. Pumping 125 gallons per minute did not lower the water. The porous stratum No. 5 appears at the artesian wells at the glucose works at Davenport, and at the paper mill at Moline, two wells being adjacent at both places, and the water flows through this porous stratum from one well to the other.—*Amer. Geologist.*

[AMERICAN CHEMICAL JOURNAL.]

THE ORIGIN OF PETROLEUM.

AN interesting contribution to the evidence of the animal origin of petroleum has recently been made by C. Engler.* There are two theories concerning the origin of petroleum; the first, the so-called emanation theory, assumes petroleum to be generated by chemical decomposition of inorganic matter, in the heated interior of the earth; according to the second theory, petroleum is formed by the decomposition of vegetable or animal matter. Several hypotheses have been suggested by different chemists in support of the emanation theory, the most prominent being that of Mendelejeff, who thinks that water penetrating through crevices comes in contact with highly heated carburets of iron and other metals in the earth's pyrosphere, forming metallic oxides and gaseous hydrocarbons, which condense to petroleum in the cooler portions of the earth's crust. While it is true that Mendelejeff and other chemists before him have succeeded in obtaining mixtures of hydrocarbons resembling petroleum by reactions in the laboratory similar to those supposed, the weight of geological and paleontological evidence is against all theories which assume an inorganic source of petroleum, and points to marine animal life as the probable source.

Recently Kramer and Bottger†, in a study of the hydrocarbons contained in crude petroleum, advanced the opinion that certain of these hydrocarbons must have been formed by distillation of organic matter at comparatively low temperature and high pressure. Engler had at this time opportunity to use an apparatus designed for factory work, in which he could distill large quantities of liquid under a pressure of two atmospheres. Influenced by Kramer's suggestion, he distilled 1,000 lb. of menhaden oil at a temperature of 350°–400° and a pressure of two atmospheres. The distillate consisted of combustible gases, water, and 600 lb. of oil resembling crude petroleum in appearance and reactions. Of this oil 26 per cent. boiled below 150,° 58 per cent. between 150° and 300°, 16 per cent. above 300°.

The two higher boiling portions have not yet been examined. By fractional distillation of the portion boiling below 150°, Engler has thus far isolated pentane, hexane, heptane, octane, and nonane of the paraffin series, and finds that hydrocarbons of the secondary series are also present; in short, this oil seems identical with that portion of crude petroleum boiling below 150°. As fish oil is a mixture of triglycerides, chiefly of oleic and stearic acids, Engler thought it of interest to distill chemically pure triglycerides of these acids, and the free acids under pressure. As apparatus he used thick glass tubes bent at an obtuse angle, in each of which he put 30 grammes of substance, and sealed the tubes, placing them in a digester so that the empty ends hung downward outside the digester. After heating for four hours at 350°, the tubes were cooled and opened, to allow the escape of gases; then resealed and again heated. This treatment was continued till the reaction seemed finished. Triolein yielded a product of which 50 per cent. boiled below 150°; tristearin 60 per cent., oleic acid 60 per cent., stearic acid 60 per cent. Engler found that the triolein under proper conditions left no residue, but was entirely changed into gases, water, and volatile oil.

To explain the fact that crude petroleum contains only traces of nitrogen, Engler assumes that on the decomposition of the animal remains under long continued pressure, the nitrogen escapes as ammonia, and refers to the work of Gregory * and Wetherill † on the formation of adipocere.

An objection urged against the organic origin of petroleum is that no free carbon is found in crude petroleum. Engler takes up this hitherto unanswered point and shows that if all of the oxygen of the triolein or tristearin should combine with part of the hydrogen to form water, 87 per cent. carbon and 13 per cent. hydrogen would remain.

The numerous analyses by St. Clair Deville and Markownikoff and Oglobin, of the American, European, and Caucasian petroleums show that crude petroleum contains an average of 87 per cent. carbon and 13 per cent. hydrogen—certainly a striking coincidence!—*Edward Renouf.*

* Ber. d. chem. Gesell. 21, 1816.

† Ber. d. chem. Gesell. 20, 595.

[JOURNAL OF THE SOCIETY OF ARTS.]

THE ECONOMIC USES OF FLOWERS.

By P. L. SIMMONDS, F.L.S.

WE are so accustomed to flowers as the showy adornments of nature, as the ornamentation of our gardens and greenhouses, and for the decoration of our persons and habitations, that we can scarcely conceive these being consigned to common uses. But in this utilitarian age men strive to convert all natural objects into some technical employment of commercial value. Hence the fragile and beautiful flowers are distilled and prepared for their perfume, medicinal and industrial properties, and are even consumed as food.

The trade in flowering plants and cut flowers is very large in all civilized countries, especially so in those where the climate is not so favorable for their production in the open air as in tropical regions. From the south of Europe, with the facilities afforded by the parcel post, our florists and individuals now import, daily, great quantities of cut flowers for bouquets and button holes.

In great cities, especially London, Liverpool, New York, and Paris, a considerable trade is carried on in flowers. Holland sends away, annually, bulbs and flowers to the value of from £100,000 to £150,000. The tulip mania of former years is well known. As the Dutch grow large quantities of bulbs, after ascertaining the color of the flowers, the blossoms were usually thrown away, until the demand for cut flowers in England led to shipments of these. This, however, was found to interfere with the sale of the bulbs. So the sale of the flowers has been stopped.

A cursory glance at the varied uses of flowers may not be uninteresting. Their employment for perfumes is that best known. Aromatic principles are more fully developed under sunny skies. In tropical regions most flowers possess a potency of aroma unknown in northern countries. Hence the perfumer looks chiefly to warm climates for his sources of supply.

The orange, the jasmine, the rose, and the acacia thrive best in the southern parts of Europe, and the most odoriferous flowers, such as the *Pandanus odoratissimus* and the *Cananga odorata*, are to be found within the tropics. *Mimusops Elengi* is much prized by the natives of India for its fragrant white flowers, which are made into garlands. The handsome, sweet-scented, white flowers of *Mesua ferrea* perfume the air to a great distance. The perfumed flower of Soka (*Pavetta angustifolia*) are used in the East for making an essence, known under the name of "ixora extract," which has become a current article of commerce in the south of Europe. The lotus flower (*Nelumbium speciosum*), common everywhere in India (one with a white and the other with a red flower), is highly venerated by the Hindoos, and is given as a valuable offering to their gods; so are the orange flowers of the *Nauclea cadamba*.

The showy and strongly scented flowers of *Plumieria alba* and *P. rubra*, and other species, natives of the West Indies and some parts of South America, have a delicious odor, and are greatly valued for distilling the perfume known as frangipanni. The yellow flowers of *Melilotus officinalis*, and other species, possess a peculiar fragrancy, which is due to the presence of coumarin, an odor found in the Tonquin bean.

From the flowers of *Acacia farnesicina* is made the essence and pomade of cassie of the French perfumers. About 100 tons of these flowers are used at Cannes yearly, individual makers working up 100,000 pounds. The fragrant white flowers of *Blighia sapida* are used for making a distilled water. The flowers of spikenard (*Andropogon Nardus*), under the name of serrbel, are employed in Algeria for perfuming hair oils and cosmetics. The aromatic white flowers of bukul (*Mimusops Elengi*) yield a fragrant water by distillation.

The rose family, of which there are so many species, is much cultivated in different localities, for the flowers to be used in perfumery as rose water or rose attar. The Provence cabbage rose (*R. centifolia*) will yield in the second or third year from 100 to 200 bushels of roses per acre, weighing six pounds to the bushel.

The culture of flowers is very general in Roumania; nearly every peasant has a small corner of his garden devoted to odoriferous flowers and herbs. The Kezanlik Valley there is entirely given up to the cultivation of roses. The essence made is sold wholesale in Paris at £30 to £40 per pound, but is retailed at double that price. The rose harvest at Adrianople has been occasionally computed to yield about 94,000 ounces of attar of roses, valued at £80,000 to £100,000, but the price has declined 50 per cent. since 1883. The average of the Bulgarian rose harvests in the past ten seasons has been over 57,000 ounces. The Moors, in Algeria, extract an attar which is not without value from the indigenous musk rose (*R. moschata*), with a double white flower.

Twenty-eight tons of rose leaves were imported into Aden in 1886, valued at £1,000, about half of which were shipped to India. The dried rose leaves which we import from the Continent are often dyed with aniline. The finest attar of roses is imported in tinned copper bottles, called "cappers." In Turkey these bottles are known as kurkoumas. The oil, sold in small gilt glass bottles, is generally much adulterated with oil of geranium or ginger grass.

The Orientals have discovered that perfumes cool a room; hence their more general use in hot countries, as well as for counteracting miasma and unpleasant smells.

The flowers of the jasmine—the odor of which is so much esteemed by the Eastern nations—serves in northern Africa to form garlands with which the Moorish females ornament the interior of their dwellings, and they obtain a perfume by simply steeping them with oil in bottles which are exposed to the sun. This process is also applicable to the flowers of the tuberose (*Polyanthes tuberosa*) and the cassia, the cultivation of which has been much extended, and both of which furnish delicious perfumes. The daffodil yields a delicious perfume, and mignonette is also esteemed for its fragrance. Hungary water is distilled from the tops of rosemary flowers with spirit. Lavender flowers are generally distilled with the stocks as gathered. The oil is chiefly used as lavender water, combined with orange and rose waters.

The flowers of the heliotrope emit a powerful odor, and are sometimes used for perfume.

The violet is an important perfume plant. Nice and Cannes use up about twenty tons annually, and one perfumer in Cannes distills 12,000 lb. There are many acres of the Russian and giant violets grown at Mitcham and its neighborhood; the first is darker in color, but the latter is most fragrant. They are tied up in bundles of twenty-five, and are sent to Covent Garden market, from whence they pass into the hands of the retail flower girls.

Orange flowers, as a perfume, have no equal. When placed in tin cans and sealed up, they have retained their odor unimpaired for many months. In the south of France orange blossoms are largely collected. Nice alone uses up 120 tons annually, and one perfumer in Cannes purchases 140,000 lb. From the flowers the essential oil of neroli is obtained. Orange flower water is largely imported from the south of France. It is one of the most agreeable vehicles for nauseous medicines that we have.

Rosebuds brought from the gardens of Tayf form a large article of trade in Djedda and Mecca. The people, especially the ladies, not only steep them in the water used for their ablutions, but boil them in sugar and make a preserve of them. The blossoms of the shaddock or pumelo (*Citrus decumana*) are used for flavoring sweetmeats. The calyces or flower bracts of the roselle, or Indian sorrel (*Hibiscus sp.*), as they ripen, become fleshy, and being of a pleasant acid taste, are made into tarts, jellies, and refreshing drinks in India.

The petals of flowers are much used in Roumania for flavoring preserves; violets, lime tree flowers, and roses are especially used. Having regard to their flavor, delicate odors, and agreeable appearance, the variety made is almost infinite, there being upward of 150 kinds of preserves and confections made in that country.

The flowers of *Hemerocallis graminea*, when dried, constitute one of the choicest delicacies of the Chinese kitchen. They are largely exported from the province of Shan Tung. The Chinese eat the young flowers of the plantain pickled in vinegar, and these are eaten also in India. The capers used at our tables are the flower buds of *Capparis spinosa* or of *Zygophyllum fabago*, which latter are occasionally substituted for real capers. The well known spice, cloves, are merely the unexpanded flower buds of *Caryophyllus aromaticus*.

The crimson dye obtained from the large deep orange flowers of safflower (*Carthamus tinctorius*) are well known in this country in the form of small round flat cakes. Safflower contains two pigment principles, which made it in former years an important dyestuff, much used for dyeing silks at Lyons. The petals yield a beautiful dye of various shades of color between red and yellow. The "pink saucers" sold contain carthamine, and this, mixed with powdered mica or talc, forms the rouge used by ladies. Chinese safflower is most esteemed, but India used to grow large quantities, the best coming from Dacca. Ten years ago the exports from India exceeded 32,000 cwt., besides that locally used; now the exports have dwindled down to 1,000 or 2,000 cwt., the trade having been killed by the aniline dyes. It is much to be regretted that the beautiful vegetable dyes used by the natives are now almost superseded by the coal tar colors. A few Indian princes have indeed tried, by prohibitory duties, to prevent their introduction into the states over which they have control.

The dried flowers of *Butea frondosa* and *B. superba*, known under the several names of dhak, tisso, toolsee, and kassaree, are extensively used in India for the production of beautiful yellow and orange dyes, and have been imported into this country. They grow in clusters of large orange red flowers, which by simply pressing them when fresh, or boiling or steeping them, if dried, in a weak solution of lime in water, produce a beautiful color. Under the name of suringee and nagkassar the flower beds of *Calysaccion longifolium*, which resemble a clove, are collected in India for dyeing yellow. The blossoms of a larkspur furnish a yellow dye in Korassan. The white fragrant flowers of the malapoo (*Cedrela Toona*) also yield a yellow color by boiling in water, which is used for dyeing women's clothes and men's turbans.

The *Sophora japonica* is cultivated in all the eastern provinces of China for the sake of the imperial yellow dye obtained from its bunches of flowers and undeveloped flower buds. They are gathered, separated from the calyx, and dried in the sun. The handsome yellow flowers of the marigold (*Calendula officinalis*) also furnish a dye. In India the flowers are made into garlands for their idols and for the decoration of houses in festivities.

A species of chamomile is grown in France for the sake of the brilliant yellow dye obtained from it, and

* Ann. Chem. (Liebig) 61, 362.

† Transactions of the Amer. Philosoph. Soc., 11.

the *Genista tinctoria*, known as dyer's weed, also yields a yellow color.

The red flowers of the *Hibiscus rosa-sinensis* supply a red dye, and have been used to polish boots and shoes. They are given in the East as an offering to the goddess of Energy. The flowers of dhai (*Woodfordia floribunda*) yield a red dye, used in coloring cotton, silk, and leather.

The flowers of the harsinghar (*Nyctanthes arbor tristis*), on boiling, yield in India beautiful but fleeting orange or buff dye, extracted from the corolla tubes. The flowers fall in numbers toward morning, and are collected either for the dye they yield or to string in necklaces for native women. The flowers are simply dried and kept in that state till they are needed for dyeing purposes. The flowers of the teak tree (*Tectona grandis*) are used in parts of India for dyeing red, and so are the beautiful flowers of *Punica granatum*. The orange flowers of *Abutilon spicatum* seem also to be in use in India for dye purposes.

The dried stigmas of the crocus are of importance for saffron, which has been highly prized from a remote period as a condiment, perfume, and dye. It is largely produced in France and other parts of Europe, and is also grown in Asia, China, Japan, and Tunis. The pistils are the only productive part of the flower, the rest being waste, and of these it takes about 70,000 to produce a pound of saffron. It is used for coloring and flavoring food, and even for dyeing morocco leather, but the price is too high to admit of its extensive use as a dye. About 219 cwt., valued at £58,000, are imported annually into India. Cake saffron is made of the florets pressed together with mucilage. As a medicine, in small doses, saffron is considered stomachic, and is prescribed in fevers. In large doses it stimulates the nervous system. A species of saffron, the produce of *Lyperia crocea*, is obtained from the Cape Colony.

Some flowers attract birds and bees by their nectar, others repel them by their stupefying odor. The insect powder of commerce consists of the florets of the disks of different species of *Pyrethrum*, collected before the seed is fully formed. The flowers of tansy are also said to have this stupefying effect on insects. The Caucasian and Persian flowers, locally known as "guirila," although at first employed for insect powder, are no longer of commercial importance. The cultivation of these flowers is now chiefly carried on in Dalmatia and Montenegro, and the trade centers in Trieste, where some 12,000 cwt. are sold yearly at the price of about £11 a cwt. The unground flowers are much preferred, as the powder is greatly adulterated. From one Russian port, Poti, this insect powder used to be exported to the value of £7,000 a year.

A considerable trade is carried on in what are known as "immortelles," or everlasting flowers, species of *Gnaphalium* and *Elichryum*. These are made into garlands, crosses, and other devices, to decorate the tombs of deceased relatives and friends in cemeteries.

Passing now to the medicinal uses of flowers, we have first the strobiles or female flowers of the hop plant, which are valuable for their aromatic, tonic, and narcotic properties. The damask roses are grown for medicinal purposes. Before the bud is about to open, the bottom, or "keel," as it is termed, is cut off, and the top dried and preserved, to make either infusion or conserve of roses. The Provence rose (*R. gallica*) is reported to be astringent.

The flowers of the hollyhock are mucilaginous and demulcent, and those of the marshmallow (*Malva sylvestris*) are much used in France, under the name of "guimave."

The red flowers of *Grisleu tomentosa* are considered an astringent tonic. In medicine we have also "balaustines," the flower of the pomegranate.

The properties of chamomile flowers have long been known to medical science. They are an exceedingly useful and cheap stomachic tonic in dyspepsia, and an anodyne. The single flowers are more odoriferous than the double ones, and yield a larger proportion of volatile oil.

An infusion of linden flowers (*Tilia Europœa*), drunk as a tea, is reported to be a cure in chronic epilepsy. They are used in France in the form of a *tisane*, and the distilled water is considered antispasmodic. The flowers of *Hibiscus rosa-sinensis* are emollient, and an infusion of the petals is given as a demulcent. Kousso, the flowers of *Brayera anthelmintica*, of Abyssinia, and the flower heads of *Artemisia* act as vermifuges.

Violets are considered purgative, but a conserve of the flowers with sugar has a grateful flavor for covering nauseous medicines. In Turkey a sherbet is made of this violet conserve.

Flowers, as we have seen, are employed in medicine, but they are also used in some instances as food. It is rarely that we find the corolla of a plant serving any other purpose than as a temporary protection for the reproductive organs within. But for a flower to secrete more than half its weight in sugar, and thus become an article of important economic value, is most remarkable. Of this we have an instance in the flowers of an Indian tree, the Mohwa (*Bassia latifolia*). Fleshy, snow-white flowers are produced in enormous quantities in March and April. They fall off and cover the ground beneath the trees, and are gathered eagerly by the natives during the flowering season, and eaten either raw or cooked.

A single tree will yield many hundredweights of corollas. These are eaten, as a rule, once or twice a day by the poorer classes of the wild tribes of Central India, and in parts of Bombay, Rajpootana, and Bengal. In Monghyr, south of the Ganges, there are about 1,000,000 of these trees, so that the yield of flowers there annually cannot be far short of 100,000 tons. The ripe flowers have a sickly smell and a sweet taste, resembling manna. They are stored as a staple of food by many tribes. When dried they have somewhat the odor and appearance of Sultana raisins. Containing 63½ per cent. of sugar, one-seventh of which is crystallizable, they are as nourishing as grain, but people could not live on them alone for any length of time. After being sundried, the flowers are prepared for eating, by being heated over a fire in an earthen vessel for a quarter of an hour, during which they are stirred with a stick to prevent burning. The flowers are sometimes bruised and boiled to a jelly, and made into small balls, and are also put into sweetmeats. The flowers are distilled by the Parsees, and yield a powerful, coarse spirit. Large quantities of the flowers were shipped to Europe a few years ago for distillation. Their commercial value in India is about 12s. to 18s. per cwt.

Cowslip flowers, fermented with sugar, form a domestic wine, and are also used for a balsamic drink, known as paigle tea. The dried blossoms communicate an aromatic fragrance to home-made wines resembling Muscatel.

The flowers of meadow sweet (*Spiræa ulmaria*) are also used by wine merchants to improve the flavor of home-made wines, and they also yield a fragrant distilled water.

Some of the Chinese teas, as orange pekoe, and caper, are often scented with flowers. The petals of the sweet flowering olive were formerly used for this purpose. Now the *Jasminum Sambac*, the Chu-lan (*Chloranthus inconspicuus*), and *Gardenia florida* are chiefly employed. One process is to take the tea hot from the last roasting, put a layer of it into a chest, and strew a handful or more of the flowers over it; this is done continuously until the chest is full; it is then closed and thus remains for twenty-four hours. The proportion of flowers is about 3 per cent. to that of tea. The tea and flowers thus mingled are put into an hour-glass-shaped basket, the sieve containing them resting on the center contracted part, so as to keep it well away from the fire. After roasting in this way two or three hours, the flowers are sifted and winnowed, and the tea thus scented will impart sufficient flavor to ten times its own bulk. It is therefore mixed accordingly, and is generally put for a moment or two into a slightly heated pan, previous to packing. Another mode is to dry the petals over a slow fire, and then pound them, sifting the powder over the leaves during the last two dryings.

Traces of these have often been found in black teas here; the Chu-lan flowers, which are green, turning almost white when seared, and looking like so much fine sawdust. A third method is by putting a sieve of the flowers under another containing the tea in the basket, and letting the fumes of the one ascend into the other. The first process described is, however, that most prevalent.

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